TABLE OF CONTENTS:

Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POST OFFICE.
OAHU.			
Apokaa Sugar Co.	*	G. F. Renton	Ewa
Ewa Plantation Co.	*	G. F. Renton	Ewa
Waianae Co.	***	Fred Meyer	Waianae
Waialua Agricultural Co.	*	W. W. Goodale	Waialua
Kahuku Plantation Co.	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co.	**	G. Chalmers.	Waimanalo
Oahu Sugar Co.	x	F. K Bull	Waipahu
Honolulu Plantation Co.	**	J. A. Low	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co.	**	Geo. Gibb	Lahaina
Pioneer Mill Co.	=	L. Barkhausen	Lahaina
Wailuku Sugar Co.	***x	C. B. Wells	Wailuku
Hawaiian Commercial & Sug. Co.	x*	H. P. Baldwin	Puunene
Maui Agricultural Co		H. A. Baldwin	Paia
Kipahulu Sugar Co.	x	A. Gross	Kipahulu
Kihei Plantation Co.	x*	James Scott	Kihei
HAWAII.			
Paauhau Sugar Plantation Co.	**	Jas. Gibb	Hamakua
Hamakua Mill Co.	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	J. M. Horner	Kukaiau
Kukaiau Mill Co.	*x	E. Madden	Paauilo
Ookala Sugar Co.	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co.	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	J. M. Ross	Hakalau
Honomu Sugar Co.	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co.	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co.	**x	J. T. Moir	Hilo
Hilo Sugar Co.	**	J. A. Scott	Hilo
Hawaii Mill Co.	x	W. H. Campbell	Hilo
Waiakea Mill Co.	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co.	**x	Wm. G Ogg	Pahala
Hutchinson Sugar Plantation Co.	**	Carl Wolters	Naalehu
Union Mill Co.	*x	H. H. Renton	Kohala
Kohala Sugar Co.	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co.	x**	K. S Gjerdrum	Honokaa
Olaa Sugar Co.	xx	J. Watt	Olaa
Puna Sugar Co.			Kapoho
Halawa Plantation	x*x	T. S. Kay	Kohala
Hawi Mill & Plantation	††	John Hind	Kohala
Puako Plantation	††	W. L. Vredenburg	S. Kohala
Niulii Sugar Mill and Plantation	*x	Robt Hall	Kohala
Puakea Plantation	*x	H. R. Bryant	Kohala
KAUAI.			
Kilauea Sugar Plantation Co.	**	Frank Scott	Kilauea
Gay & Robinson	x*=	Gay & Robinson	Makaweli
Makee Sugar Co.		G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co.	x	F. Weber	Lihue
Koloa Sugar Co.	x	P. McLane	Koloa
McBryde Sugar Co.	*x	W. Stodert	Eleele
Hawaiian Sugar Co.	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co.	*	J. Fassoth	Waimea
Kekaha Sugar Co.	x	H. P. Faye	Kekaha

KEY.

.....	Castle & Cooke ..... (5)
**	W. G. Irwin & Co. ..... (8)
***	J. M. Dowsett ..... (1)
x	H. Hackfeld & Co. ..... (9)
*x	T. H. Davies & Co. ..... (8)
**x	C. Brewer & Co. ..... (6)
x*	Alexander & Baldwin ..... (6)
x**	F. A. Schaefer & Co. ..... (2)
x*x	H. Waterhouse Trust Co. ..... (2)
††	Hind, Rolph & Co. ..... (2)
xx	Bishop & Co. ..... (1)

HONOLULU AGENTS.

THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

[Entered at the Post Office at Honolulu, T. H., as Second-class matter.]

Vol. XXV] HONOLULU, AUGUST 15, 1906. [No. 8

SUGAR PRICES MONTH ENDING AUGUST 14, 1906.

	Centrifugals.	Beets.
July 17	3.71875¢	8s. 3¾d.
July 24	3.75¢	8s. 6¾d.
July 31	3.75¢	8s. 6¾d.
August 7	3.875¢	9s. 1½d.
August 14	3.875¢	9s.

Messrs. Willett & Gray in their weekly circular of August 2, say:

A marked improvement has taken place both in sugar conditions and in prices during the week under review; just at the time when it was to be supposed by many that the improvement in the raw sugar market, which has been going on for so long a time, would be nearing its completion, the market has taken on a new lease of life, showing its vigor and strength in the phenomenal rising tone and tendency. This is only, however, in confirmation of the market prospects which we have frequently given for this campaign, and the advancing markets, which we have forecasted, have by no means culminated, but rather the prevailing conditions now point directly to a further and sharper rise than any we have yet had in both raw and refined sugars. The prevailing facts now influencing the market are that the United States has drawn more largely than usual upon the Cuban supplies, ignoring those of Java which have gone to other markets. Our Java cable of shipments is not yet in, but from what is known of the movement of the Java crop, through other cables, it is quite possible that up to the present time, some 200,000 tons less sugar has been shipped to the United States than last year. This leaves a minus in supplies of 200,000 tons from that source for arrival here.

The drawing upon the Cuba crop leaves that market something like 100,000 tons minus supplies for the immediate future. When

it is considered, also, that there is nothing approximating these minuses, to be had in Europe, but beet sugars, under No. 16 D. S., suitable for the American market, and that European holders are advancing their general supply of beets, quite as rapidly as we advance, it will be readily seen that a more or less important crisis is coming in the matter of continued supplies of raw sugars in the United States to meet the largely increased consumption demand now going on in the country. In connection herewith we print a letter from our correspondents in Java, which will be found very interesting.

The advance of the market for the week is 1-16c. per lb. c. and f. basis to 2 7-16c. for 95° test basis equal to 3.83c. duty paid for 96° test basis, while the spot quotation has advanced 5c. per 100 lbs. to 3.80c. duty paid for 96° test Centrifugals. A much more important feature of the market, however, is that these notable conditions becoming known, have caused holders generally to withdraw their sugars from the market so that, at the close, it is somewhat difficult to say at what basis new business will be put through, although there are moderate offerings of Porto Ricos for prompt shipment at 3 7-8c. basis 96° and Cubas at 2 1-2c. c. and f. basis 95°, equal 3.89c. duty paid for last half of August.

European markets have followed our advance closely, closing at 8s. 9 3-4d., against 8s. 6 3-4d. at the beginning of the week.

It is thought that business was done yesterday in beet sugars at a price supposed to be 9s. 1 1-2d. c. and f. (parity 3.82c. for Centrifugals), but particulars are withheld. At the close 9s. 3 3-4c. c. and f. (parity 3.87c.) is asked.

Javas have also advanced with our markets, and no business is reported, holders at the close asking 10s. 3d. c. and f. for August-September shipment, which is considerably above the present market.

Batavia, Java, June 23, 1906.—Exports Versus Crops.—That there were more than 100,000 tons of the 1905-06 crops still left in Java at the end of April can hardly be assumed. Of course, there is always something left in the island, but how much this may be is very difficult to say, the more so as we are not in a position to judge how much there is still to be shipped to Hongkong and Japan against old contracts. On the other hand, you will kindly bear in mind that we have no proper official statistics here in Java, i. e., the statistics published by the government are all but reliable, whereas the customs statistics, which are, of course, correct, may not be taken insight of. Thus we are dependent on the statistics compiled by the secretary of the Batavia Exchange, with the help of the European export firms, which, however, are never quite complete, as it is next to impossible to get hold of the figures representing the quantity of sugar exported by Chinese dealers to Chinese and other eastern ports, and the more this busi-

ness to China will increase, the more difficult it will be to trace the difference you are referring to. The 100,000 tons, of course, also comprise all the sugar consumed in the whole of Netherlands India.

As regards the growing crop, we think that, compared to former years, very little will go to America, but that the larger part will be taken by the East; and with a view to the steadily increasing business with China and British India, the *manufacture of White Crystals* has materially increased too, and it is not at all impossible that the exports of this article will reach the figure of 100,000, which has been reported to you. Up till now about 65,500 tons of White Crystals, so called, "Superior," of the present crop, have been sold by planters to exporters, and we may safely assume that 30,000 to 40,000 tons are still unsold in planters' hands. Whether planters will find it profitable to go on making so much superior sugar in future, naturally still wants to be seen, but in consequence of the altered situation of the market, many manufacturers have improved their plants so as to be able to make superior and high grade sugars without much extra expense in order to be less dependent from buyers in the United States.

Hand in hand with the manufacture of white crystals that of *white second boilings* has likewise increased. To our regret we have no sample of the latter at hand. Whereas Superior First Runnings are chiefly exported to British India, Superior Second Boilings go mostly to China, being more to the Chinese taste. Of white seconds, ex running crop, high numbers and superior, the not inconsiderable quantity of 45,000 tons has already been contracted, and we think that we shall not be far out in estimating the total figure for this kind of sugar for the growing crop at 60,000 tons.

Estimate of Present Java Crop.—So far we felt inclined to put the complaints which were raised here and there about the less promising results of the harvest down to special precautions taken by planters towards their financing banks, but according to reports lately received, we think now that the crop of 1906 promises to be somewhat smaller than that of 1905, and even if we take into consideration that the quality of the cane may improve a little towards August, when drought has well set in, we think that the present crop will be about five per cent. less than last year's. We, therefore, telegraphed you yesterday that we estimated the present crop at 950,000 tons, which figure is, of course, to be taken approximately, and may be modified in the course of the harvest, but we think the outturn will rather be smaller than larger. It is only since a few days that all sugar mills have started working, and as the harvest lasts till the end of October or beginning of November there depends very much on the weather.

Mr. F. O. Licht in his "Monthly Report," dated July 14, sums up the general situation as follows:

The consumption of sugar in the various countries was as follows:

	In the month of June.			In the 10 months Sept.-June.		
	1906 Tons.	1905 Tons.	1904 Tons.	1905/06 Tons.	1904/05 Tons.	1903/04 Tons.
Germany	91,057	77,812	89,657	895,381	782,607	918,519
Austria	44,645	36,279	36,599	428,176	365,987	411,415
France	54,000	45,893	66,124	540,255	512,177	668,720
Holland	9,018	6,699	7,062	81,480	73,747	82,840
Belgium	7,131	6,499	7,989	68,017	63,986	80,426
England	165,453	142,447	146,241	1,490,111	1,320,848	1,308,263
Total	371,304	315,629	353,672	3,603,420	3,119,352	3,470,183
America	200,556	162,000	166,235	1,527,561	1,464,880	1,456,759
Total	571,860	477,629	519,907	5,130,981	4,584,232	4,926,942

From this there results that in this June alone, when compared with the same month of the preceding year, 94,231 tons (19.8%) more were consumed; when compared 1904, 51,953 tons (10.0%) more was consumed; while the increase for the period commencing with Sept. 1st amounted to 546,749 tons (11.9%) and 204,039 tons (4.1%).

The production of beet sugar during the first ten months shows an increase of 2,119,000 tons, against the preceding year. Imports show for Europe and North America together a surplus of 382,000 tons, for Europe alone a such of 270,000 tons, while the stocks on September 1st, in Europe and North America together, were 293,000 tons smaller, in Europe alone 350,000 tons smaller, than 12 months previously. From the sum of these three groups of figures, there results for Europe and North America together a more of 2,208,000 tons, and for Europe alone a such of 2,039,000 tons. At the end of June the stocks in Europe and North America together were 823,000 tons, in Europe alone 717,000 tons higher, than 12 months previously, and the consumption, taking into account an increase of 910,000 resp. 910,000 tons in the exports, showed during the 10 months an increase of 475,000 tons, for Europe alone a such of 412,000 tons. But for the twelvemonth ending end of June, there results for Europe and North America together a increase of 305,000 tons for Europe alone a such of 240,000 tons.

NOTES.

SUGAR GROWING IN THE WEST INDIES.

A recent number of the "West Indian Bulletin" contains a very interesting review of the work of the Imperial Department of Agriculture, a portion of which, relating to the sugar industry, we have reprinted in this issue.

Much attention has been given in the West Indies to the scientific investigation of questions affecting the sugar industry, and especially to the raising of new varieties of canes capable of resisting disease and producing larger yields of sugar per acre. Experiments in fertilizing have also been carried on, results of which have been given out from time to time.

Cane diseases and pests have been as prevalent in the West Indies as in Hawaii, and in the Leeward Islands fears were at one time entertained that on account of the invasion of such diseases, cane growing would have to be abandoned. The introduction of new varieties, however, solved the problem and there seems to have been a great revival of the industry.

In methods of cultivation our West Indian friends are also coming to the front. The past year has witnessed the introduction of steam plows, and with the consequent deeper cultivation of the soil it is expected that better results will be obtained and drought conditions will be minimized.

While such steady progress has been made in the raising of new canes and in the selection and use of fertilizers, the manufacturing and extracting methods are still lagging behind and are far from satisfactory. A sentiment is growing in favor of the establishment of well equipped central factories and one such has already been established in Antiqua; and the opinion of well informed sugar growers is that it will be impossible for the industry to be profitably carried on with the large losses that now attend the present system of manufacture with the small and imperfect crushing machinery now in general use.

HAWAIIAN CROP.

The majority of the plantations have taken off the crop and finished grinding, but there are a number that, on account of shortage of labor, will not see the end of the season for some time to come. The weather conditions on the whole, have been very favorable for harvesting and had there been an abundance of labor the season would have been finished in good time. Labor conditions have been worse this season than for some years past and reports have come from a number of plantations

of the abandoning of considerable rattoon cane that they were unable to cultivate. While some loss has resulted in the deterioration of cane from standing so long, and also to the 1907 crop from late planting, there will be some compensation in the higher prices which will be realized by the late sugar.

There has been little complaint on the score of cane pests or diseases. For this the planters may largely thank the Experiment Station for the very efficient work that has been done by all its departments and for the information and advice that has issued therefrom.

The approximate output of the crop is 400,000 short tons, of which probably two-thirds has been marketed. This is 20,000 tons less than the output of the last crop and is the third largest in the history of the sugar industry of the Islands.

The Hawaiian Commercial & Sugar Company at Maui, with a total output of 43,562 tons, holds the record for the largest crop ever produced here by any plantation. Ewa plantation, heretofore the largest single producer, this year takes second place with 30,160 tons.

The utilization of the Nitrogen of the air is one of the most important industrial problems of the day, and of particular interest to everyone connected with agriculture We devote considerable space in this issue to a partial reproduction of an extremely interesting paper on "The Electro-Chemical Problem of the Fixation of Nitrogen," prepared by Prof. Philippe A. Guye and read before the London Section of the Society of Chemical Industry at Burlington House, May 21st, 1906.

CORRESPONDENCE.

Honolulu, 13th September, 1906.

To the Editor of the Hawaiian Planters' Monthly.

Sir: Referring to the publication in your June number, of a "Comparative Test of Water-driven and Belt-driven Centrifugals at Ewa Mill," the accompanying criticism of the test by Mr. Donald, chemist at McBryde Plantation, may be of interest to your readers.

The Ewa report *does* read like a bit of special pleading in favor of the belt-drive, especially in the last sentence of it where the extravagance of driving by water is emphasized by the iteration, "power, steam, fuel." Surely it would have sufficed to say

that, at Ewa, the Water-driven Machines took more fuel oil than the others to dry a pound of sugar. That they do is no evidence against the general principle of driving Centrifugals by water power: it only shows that, at Ewa, the principle is not being very well applied.

The Water-driven Centrifugal is comparatively new, and, since it was introduced here, many improvements have been made on it. There are now 40-inch machines being made that will get up full speed in less than a minute, with the ordinary load in the basket. The latest ball-bearing machines have only one spindle, no brass or other bushing, and they will run through the crop with a single application of grease to start with; there is no oil required. As compared with belt-driven centrifugals, they take up less floor space, and have no belts nor friction gear to keep in repair and adjustment. In a set of them, the work done will be the same in each machine; with the belt-drive this result is attained only when all the belts and friction-gear are adjusted to the same tension. There is this to be said for a belt-driven installation, that one or more machines running will help another to start.

Mr. Donald mentions some important points not referred to in the report, but he does not point out that, at Ewa, the belt-driven centrifugals are run by a Corliss engine, the water-driven by direct-acting pumps. Which is the more economical steam-user?

There are other queries which suggest themselves, for instance: Are the perforations in the shells of the baskets the same? Have the 00 screens the same number of backing linings in both cases? Was the thickness of the walls of sugar the same? Were the pumps in good order or how fast do they go with all the valves on the machines shut?

ROBT. CATTON.

The report presented to Mr. Renton of Ewa by Messrs. Boswell, O'Dowda and Greenfield, on their comparative tests of Water-driven and Belt-driven Centrifugals, is very interesting, and the data obtained by them in regard to fuel consumption are of some value.

There are some important points, however, which have not been referred to in the report. There were 13 water-driven and 32 belt-driven centrifugals in the test, and it is essential to know what the interest on the cost of each installation amounts to. The expense of repairs and upkeep should also be given and calculated to one ton of sugar. And, finally, no note is made of the labor employed. In general, it takes the same amount of labor for one 40-inch water-driven machine as for a 30-inch belt-driven

machine, so that there should have been less than half the labor employed on the former that there was on the latter. This compensates for the greater output of the 30-inch machines.

The water-driven machines at Ewa seem to be of inferior design. Here (at McBryde's) with 180 lbs. water pressure, and two nozzles open, the ball-bearing 40-inch machines reach full speed (900 to 1000 R. P. M.) in 2½ minutes, and the washer-bearing machines in 3 minutes. With only one jet, the machines take 5½ minutes to get up full speed. The water-driven centrifugal, therefore, has not received an absolutely fair test at Ewa, and it is probable that a 40-inch belt-driven machine running at the same speed would not have made a much better showing.

I am not defending the water-drive against the belt-drive, but only wish to indicate the weak points of this test. I agree with the Ewa people (as against Watson, Laidlaw & Co.) that a rapidly starting machine will do better work than a slow starting machine with any massecuite irrespective of grade.

The sampling and analyses seem to have been very carefully performed, as the polarizations and yields correspond with the given purities of massecuite and molasses. But the statement that belt-driven machines give molasses 3 per cent. lower in purity and a yield of sugar 5.7 per cent. greater than water-driven machines is very sweeping, and based on very faulty data as shown above. The fact that these results were actually obtained indicates that the massecuite treated was full of false grain, and is rather an argument for crystallizers than for any particular type of motive power for the centrifugals. If the grain is well formed it will not pass through the screen in quantities which will affect the purity of the molasses to any considerable extent, no matter how fast or slow the machine may be in starting, unless the perforations are unnecessary large. Even with a bad strike, the test only shows the superiority of a *quick-starting* centrifugal over a *slow-starting* one, and not of the belt-drive over the water-drive, for there are water-driven machines on the market which get up full speed almost as quickly as belt-drive ones.

In conclusion, the only deduction we can make from the Ewa experiments is that the belt-drive is more economical of fuel, and even this deduction is made of uncertain value by the inferior make of water-driven centrifugal used in the comparison.

It is evident to me that my friends, Messrs. Greenfield and O'Dowda, have not approached the question in a perfectly judicial, unbiassed frame of mind, but have been strongly predisposed in favor of the belt machines, which also lessens the value of the tests.

JAS. W. DONALD.

*FIXATION OF ATMOSPHERIC NITROGEN.**

English science has contributed largely to the solution of the electro-chemical problem of nitrogen. Without going back as far as Cavendish's experiments on the transformation of nitrogen into nitrous vapours, we will restrict ourselves to modern researches; it will be enough for me to mention the name of Sir William Crookes, whose experiments of 1893 and whose suggestive address as president of the British Association in 1898 are still present in your minds. Furthermore, there are the experiments of Lord Rayleigh (1897) on the combustion of nitrogen. And lastly, this problem has been recently treated in a particularly competent way before scientific circles by Prof. Silvanus Thompson and before the general public opinion of your country by my friend, Sir William Ramsay.

I have followed very closely the development of the large Swiss electro-chemical enterprises which utilize hydro-electric power. Moreover, for some years past, in connection with the "Societe d'Etudes Electrochemiques a Geneve," I too have been coöperating in researches on the fixation of nitrogen on a semi-industrial scale. Under these circumstances, I hope to be able to secure your attention to special points which have stimulated the study of this interesting problem in the electro-chemical circles of our country.

Before entering on my subject, I have to ask your indulgence in frequently bringing before you numerical tables and data. It is, however, the only way of emphasizing the fundamental points of this important question.

I.—IMPORTANCE OF THE PROBLEM.

The part played by nitrogenous bodies in economical problems has been so frequently discussed during recent years, that it is unnecessary for me to describe it at length. Certain figures, taken from recent statistics, will suffice as a resumé of the most important economical data which dominate its whole study.

The two principal sources of nitrogenous matter of which use is made by civilized nations are Nitrate of Soda from Chili, and Ammonium Sulphate.

In 1905, the entire consumption of Chili Nitrate was 1,567,000 tons; while that of 1896 was 1,060,000 tons. Of these 1,567,000 tons, we can reckon about 300,000 tons as having been

*From address of Prof. Philippe A. Guye before London Section of the Society of Chemical Industry.

utilised in chemical industry (80,000 to 100,000 tons in the United States and the rest in Europe).

The two principal chemical uses in Europe are: (1) the manufacture of nitrites; and (2) the manufacture of pure nitric acid for explosives, colours, etc.

The use of nitrate of soda as manure is represented by the balance, approximately 1,267,000 tons for 1905; this consumption is rapidly increasing, especially since a commencement has been made in the direction of applying nitrogenous manures to the culture of corn in the United States. Recent calculations by M. Vergara, which have taken into consideration the increase in the consumption of the last few years, indicate the year 1923 as the date when the Chili beds will be exhausted.

This date will be still nearer if we accept the statement made by Sir William Crookes, who estimates that the quantity of nitrate necessary to meet the yearly increasing needs of the "wheat eaters" will be more than 12,000,000 tons after 30 years or so.

Although not quite so considerable, the consumpton of ammonium sulphate is by no means less important: it is impossible, however, to obtain statistics for this product as definite for nitrate, on which duty is paid at the Chili ports of embarkation and on arrival at European and American ports: nevertheless, those most competent to form an opinion, compute that the entire production of ammonium sulphate in 1905 reached at least 500,000 tons (others, however, reckon it as high as 600,000 tons). This quantity is distributed approximately in the following proportions:

220,000 to 250,000 in Great Britain.
100,000 to 120,000 in Germany.
70,000 to 80,000 in other European countries.
50,000 to 60,000 in America.

The larger part is utilised for agriculture, chemical industry using only 10 to 15 per cent. of the total amount produced. The European consumption would not exceed 350,000 tons.

A large fraction of this product, namely that manufactured in Great Britain, is exported outside Europe, particularly to the East.

This sulphate of ammonium is derived exclusively from gas and coke works. Three years ago, it was estimated that the recuperation of ammonia was only practised in about half of the entire number of coke ovens. Since then there has been tendency for it to become more general. It will be enough to add that only 10 to 15 per cent. at most of the nitrogen contained in the coal is obtained in the form of ammonia.

At the present rate the production of sulphate of ammonia

is, however, insufficient to meet the increasing needs for nitrogen which we may expect in the future.

As regards the commercial value of the nitrogen contained in Chili saltpetre and ammonium sulphate, compared with that of the nitrogen in nitric acid, it may be expressed in the following figures which are based on the market of Great Britain for 1905:

Product.	Value of 1 kilo. N.
Chili nitrate containing 16.5 per cent. N.....	31¢
Sulphate of ammonia, containing 21.2 per cent. N.	29¢
Nitric acid, containing 22.2 per cent. N.....	45¢

The nitrogen contained in nitric acid has a higher value than that contained in sulphate of ammonia. This can be easily understood, seeing that the expenses incurred in industrial operations for transforming the nitrate into nitric acid must be covered. As to the difference between the nitrogen of the nitrate and that of ammonia, it may be explained by the fact that for the same weight of nitrogen, manures containing nitrate give for most agricultural purposes, and especially for cereals, slightly superior results to those obtained with ammonium sulphate manures. A few years ago a superiority of 10 to 20 per cent. was attributed to the nitrogen of the nitrate over that of the ammonia salt. The difference in price is now slightly less.

Having sketched the general position, it still remains for us to examine how far electro-chemical industry will contribute to equalize the insufficiency of nitrogenous bodies which is to be expected in the near future.

The electro-chemical processes which have been proposed for fixing atmospheric nitrogen are at the present moment very numerous. Most of them have as yet only been studied very summarily; several reviews have published detailed resumes on this subjecet of which the following may be more especially alluded to:

Electrochemische Zeitschrift, 1905; Revue generale de chimie pure et appliquée (1906); Moniteur de Quesneville, 1906. We will confine our attention to methods which have received industrial application, in order to be able to throw light on the principal economical factors on which final success depends. The number of these methods at the present day is two: the first produces calcium cyanamide ("Kalkstickstoff" or chaux azotée") the other nitric acid and nitrates.

II.—CALCIUM CYANAMIDE.

General Considerations.—In the course of their researches on the cyanides, Drs. Frank and Caro observed that barium carbide, BaC_2, heated to a high temperature, combines nearly quantitatively with nitrogen to form barium cyanide.

$$BaC_2+N_2=Ba(CN)_2.$$

When they tried to apply this reaction to calcium carbide, they were surprised to find that the quantity of cyanide formed was much less than the theoretical amount. Further study revealed the fact that the reaction is different from that which occurs in the case of barium carbide and that in the case of calcium carbide. it is represented by the equation:

$$CaC_2+N_2=CaCN_2+C.$$

The carbide gives off half of its carbon and changes, not into cyanide, but into calcium cyanamide. This body can be considered as a derivative of ammonia (cyanamide):

NH_3	$NH_2—CN$	$Ca=N—CN$
ammonia	cyanamide	calcium cyanamide.

When cyanamide is heated with water under pressure, ammonia is set free according to the reaction:

$$CaCN_2+3H_2O=CaCO_3+2NH_3.$$

When distributed on the ground the same reaction goes on more or less slowly, and it is therefore easily understood that cyanamide has given very interesting results when used directly as a fertilizer.

Theoretically, the mixture of calcium cyanamide and carbon produced by the reaction given above should contain about 30 per cent. of nitrogen. As a matter of fact the content of nitrogen in the raw calcium cyanamide is less than this amount, either on account of impurities in the calcium carbide or of the change which it undergoes during the process of transformation. According to the communications of Dr. Frank, the content of nitrogen varies from 14 to 20 per cent. The product of recent manufacture is stated to contain about 20 per cent. From this it will be seen that this amount approaches that of sulphate of ammonia.

The economical future of calcium cynamide is clearly dependent on its cost price. According to the manner of manufacture this cost price itself depends—

1. On the cost price of calcium carbide;
2. On the cost price of nitrogen;
3. On the cost of transforming the carbide into cyanamide.

The author then gives estimates of the cost of the raw material, (calcium carbide,) which at the present time costs under the most favorable conditions $28.00 per ton to produce, the cost to the average European factory is $37.00.

Cost of producing 1 ton of calcium cyanamide containing 20% nitrogen, based on above cost of raw material:

	$	$
1 ton carbide, containing 80 per cent. CaC_2	28	37
200 kilos. nitrogen	4	4
Manufacture, pulverization of carbide, charge and discharge of retorts, heating retorts	4	4
Necessary repairs of mills retorts, liquefying machines	5	5
General expenses	2	2
Packing	4	4
Transport	4	4
Depreciation and interest on capital invested	3	3
Cost price per ton	$54	63
The price of 1 kilo amounts to	27¢	31.5¢

At first sight, the price of a kilogramme of nitrogen amounts approximately to the same as that of ammoniacal nitrogen or that of nitrate nitrogen.

But in order to make an exact comparison we must also take into account the coefficient of the agricultural utilization.

According to the different experiments the value is not yet determined with great accuracy; it seems to depend on the nature of the body and on the manner of utilizing the calcium cyanamide as manure. The figures given are between 0.64 and 0.95, Chili nitrate being taken as unity. Adopting, for instance, the average 0.85 it will be seen that the kilogramme of nitrogen, with carbide at $37.00 per ton, is already more expensive than the nitrogen of ammonium sulphate; in this case, the manufacture of calcium cyanamide appears to be industrially possible only with carbide at $28.00 per ton.

At this price it is evident that the carbide works have every interest in using for this purpose only the excess they are unable to sell for the production of acetylene, carbide intended for lighting purposes giving them a higher profit; at the present time, this product is taken on the average at $40.00 per ton, (without packing). It realises even higher prices in France and Italy.

III.—ELECTRO-CHEMICAL NITRIC ACID.

General Considerations:—The second way of fixing atmospheric nitrogen has, as its starting point, an observation of Priestley, confirmed and amplified by Cavendish (1784), who found that nitrogen and oxygen combine slowly under the action of electric discharges to form oxides of nitrogen, which then change, by more or less complex chemical processes, into nitric acid, nitrous acid, or nitrates and nitrites.

The fundamental reaction is therefore, according to the happy expression of Sir William Crookes, a real "combustion" of nitrogen in oxygen. But we may add, in order to be precise, that this combustion is "slow and lazy," since it goes on only as long as the electrical energy continues to act and since it also stops as soon as the content of nitrogen oxides in the gas has attained a certain limiting value.

For about 10 years attempts have been made to devise a process of manufacture of nitric acid on this basis. I do not intend to describe in detail the various methods which have been suggested, but will summarize the general conclusions which may be drawn from these researches. I should state, however, that the first attempt of this kind, made in Switzerland, was due to Aloys Naville in 1893, who proposed to me shortly afterward to study this problem in collaboration with him and Prof. C. Eug. Guye.

The principal results of this collaboration have been condensed in patents taken out in 1895 and 1896, in which we formulated for the first time a principle which appears to us fundamental; it is that the yield is notably increased when the electrodes are placed in a narrow part of the chamber, in which the reaction takes place, in order to submit the whole of the gas to the action of the electric energy and to draw off as rapidly as possible the gases which have been subjected to this action.

Electric Energy.—The most favorable results as yet published indicate a production of 900 kilos. HNO_3 per kilowatt-year, measured at the arcs (Eyde and Birkland). (All the yields are calculated as nitric acid of 100 per cent. HNO_3.) Prof. Haber has calculated a theoretical yield of 1800 kilos. per kilowatt-year. According to Prof. Witt the quantity of nitric acid obtained at Notoden during last summer amounted to between 500 and 600 kilos. per kilowatt-year. In one of their patents the Badische Anilin und Soda Fabrik mentions that they obtained 650 kilos.

At the "Société d'Etudes Electrochimiques" at Geneva, with extremely simple and cheap apparatus, we have obtained a yield of about 400 kilos, of nitric acid.

It seems then, that we may take a production of 500 kilos. HNO_3 per kilowatt-year as being a fair average. This production may be greater or less according to the degree of simplicity of the apparatus employed. Without doubt, the yield will be certainly increased in the future; in reality we are only in the introductory stages of this industry.

Recovery of the Oxides of Nitrogen.—The process of recovery, which has been, up to the present, adopted by different experimenters, is based on the absorption of these oxides by water. Prof. Witt states that approximately 95 per cent. of the nitrogen oxides thus formed at Notoden are recovered.

In reality the recovery is not so simple as it might appear at first sight; for the chemical mechanism of the fixation of nitrogen oxides by the elements of water is extremely complex.

At Notoden, the products of three furnaces, each 700 h. p. (500 kilowatts), are conducted into a system of two parallel series of five granite towers, each of which has a capacity of 40 cb. m.; in each of the series the last tower is filled with milk of lime in order to retain the poorer gases. The capacity of the system is thus 400 cb. m.; its power of absorption amounts to 3.3 kilos. of HNO_3 per cubic metre in 24 hours. This corresponds approximately to the capacity of production in lead chambers (2 to 4 kilos. per 3 m. of chamber, acid of density 1.5 to 1.6), which is equal to from 2 to 4 kilos. per cubic metre.

As the result of the researches made by the "Société d'Etudes Electrochimiques," it is more advantageous to employ sulphuric acid as absorber; the power of absorption of this latter being in reality much greater than that of water. On the other hand, the methods of absorption by water are capable of considerable improvement.

The "Société" is now engaged in studying certain newly patented process by which either dilute nitric acid of 50 per cent. HNO_3 is directly produced, or fuming nitric acid containing 96 per cent. HNO_3.

The plants built in Norway, which represent nearly 0.3 cb. m. capacity per kilowatt, seem to be somewhat expensive, especially if we take in consideration all the accessories they demand (tubulated cooling system, extensive canalizations for both gases and liquids, ventilators, pumps, etc.). No actual figures have as yet been published as to the cost of that plant; but their principal dimensions being given, it is not difficult to estimate approximately the cost; it must reach to between $60 to $80 for each kilowatt used in the furnaces. The sum necessary to keep all this material in repair ought to be a considerable fraction of the current expenses.

By the recuperation by means of sulphuric acid, I estimate the capital invested at $40 per kilowatt.

Having established these points, we find that the cost price of a ton of nitric acid is represented by the following figures:

Electric energy at $10 per kilowatt-year for a production of 500 kilos. per year	$ 20
Repairs	8
Wages and general expenses	2
Depreciation and interest on capital at 5 per cent	11
	$ 41

To this price of $41 we must add the expenses of packing and transport; these will be entirely different according to the form in which the product is delivered. This fact allows us to distinguish the two following additional expenses:

Lime, 0.45 ton at $3.00 the ton and handling thereof	$3.00
Packing (air-tight drums)	5.60
Transport (the same figure as for cyanamide)	4.00
	12.60
Expenses of production	41.00
Price per ton HNO_3 delivered as nitrate of calcium	53.60
Cost price of nitrogen per kilogramme in the same form	.25

2. When the nitric acid is delivered direct as acid (in particular as concentrated nitric acid). In this case it would be enough to add to the above mentioned sum of $41.00

The expenses of packing and transport	10.00
Price per ton HNO_3 delivered as nitric acid	$51.00
Price per kilogramme nitrogen	.23

We have already mentioned that the actual value of nitrogen per kilogramme is the following:

31¢ in Chili nitrate.

45¢ in chemical nitrate acid.

On comparing these figures we may conclude that electro-chemical nitric acid can compete successfully with the last two products. Besides that, the price of electro-chemical nitric nitrogen per kilogramme is practically the same as that of the nitrogen contained in calcium cyanamide prepared from the excess in the manufacture of carbide (27¢) if we do not take into consideration an agricultural coefficient of the cyanamide.

IV.—FUTURE PROSPECTS.

If we attempt to compare the characteristic features of the two principal methods of electro-chemical fixation of nitrogen, which occupy at the present moment the attention of manufacturers and economists alike, we observe in the first place

that the yield per unit of electric energy is superior in the cyanamide process.

Yield in Nitrogen per Kilowatt-year.—With one kilowatt-year electric power, we obtain 2 tons carbide=400 kilos. fixed nitrogen. With the same power we obtain 0.5 tons HNO_3=111 kilos. fixed nitrogen.

Nevertheless, the cost price per kilogramme of fixed nitrogen is no higher in the electro-chemical nitric acid process (without taking into account an agricultural coefficient for cyanamide):

Cost Price per Kilogramme Fixed Nitrogen.—By the cyanamide process, carbide at $28 a ton=27¢: carbide at $37 a ton=32¢. By the electro-chemical nitric acid process, as basic nitrate of calcium=24¢: as nitric acid=23¢.

PROFIT PER KILOWATT INSTALLED.

The capital invested for one kilowatt installed is almost the same for the two processes, that is $40 to $60.

With Cyanamide.—Nitrogen sold at the price of that of ammonium sulphate; 400×(29—27)=8.00 $.

With Nitric Acid.—(A) Nitrogen sold at the price of that of Chili nitrate: 111×(31—24)=7.77 $.

(B) Nitrogen sold at the price of that of nitric acid: 111×(45—24)=23.31 $.

The lower price of nitrogen in nitric acid is due to the fact that the yield, although smaller in the last-named process, is greatly compensated for by the extreme simplicity of the operations and also inasmuch as it is unnecessary to take the price of raw materials into account.

If we consider the matter, it is really impossible to imagine more simple operations than the oxidation of atmospheric nitrogen and the subsequent absorption of the oxides of nitrogen formed.

Nitric nitrogen offers in itself several important economical advantages which it is interesting to examine briefly.

To begin with: as regards agricultural needs it is evident that calcium nitrate, closely related as it is to sodium nitrate, has before it almost unlimited prospects which are daily increasing. It is already well known that all the nitrates of alkalis or of lime are as good manures as the nitrate of soda.

In the second place, electro-chemical nitric nitrogen has before it an extremely brilliant opening, through its sale in the form of nitric acid, which represents in Europe alone a market of about 200,000 tons. It looks as if it were an economical error in this new industry to supply, in the first place, nitrate of calcium, as is done in Norway, instead of nitric acid. The nitric acid leaves a greater margin for profit as has already been shown. Our principal efforts ought, therefore, to be concen-

trated on the manufacture and sale of this acid, which would make it possible for the factories to pay off rapidly the capital invested on the initial plants, at the same time perfecting the technique of the processes. It is all the more to the interest of this industry to follow this branch, since the uses of nitric acid are continually increasing and others are to be expected as soon as its price has sunk lower.

To continue, as regards the future of the two industries, we think that the development ought not to be considered as that of two rivals in the usual sense of the word.

The principal aim in the development of the nitric industry should be that of the production of nitric acid, at the same time with a view to increasing the yield. It will have consequently before it a very large future, in the manufacture of nitrate.

On the other hand, the cyanamide industry is destined, at first, to be linked with the carbide industry; considering the actual cost price of calcium carbide, it will scarcely be possible to develop this industry anywhere but in the neighborhood of carbide works, possessing favorable economical conditions; and even then it would only employ the excess of carbide not absorbed for lighting purposes. We have already observed that the sale of carbide for lighting is much more remunerative. If all the circumstances are not especially favorable, the building of large carbide factories, destined exclusively for the manufacture of cyanamide, seems to be more or less hazardous; especially if we take into consideration the diminution in price of nitric nitrogen, which can be considered practically certain to take place in the more or less near future. Other considerations, which will be examined a little later, give further weight to this argument. Although limited in this way, I consider that the field for activity still remains very large.

Finally, I should like to add that it is all the more in the interest of these two growing industries not to consider themselves as rivals, for they can benefit themselves by working hand in hand with a view to better utilization of the atmospheric elements—nitrogen and oxygen—as I have already suggested in my lecture before the Société Helvétique des Sciences Naturelles. In the cyanamide industry, the atmospheric oxygen is actually lost; whereas it might be employed with advantage in the manufacture of electro-chemical nitric acid, in which the addition of this gas to the atmosphere constitutes a favorable factor in increasing the yield per unit of electric energy.

Captivating as the prospects are which are open to these two young industries, it may be well to glance at several exterior factors liable to promote or retard their development.

We have just indicated the importance of liquid air in this

respect; it is certain that every progress realized in this branch ought to be considered as a factor favorable to the rapid extension of the process of electro-chemical fixation of nitrogen.

A question not less important concerns the production of electric energy, which is indispensable to the extension of these processes. It is certain that the first nitrogen works will make use of this energy at a low price, furnished as it will be by large hydro-electric stations; however, we must not deceive ourselves and certainly not forget that this source of energy is more limited than is generally realized. The hydraulic forces still available, and at the same time favorably situated, reach in Europe a power of several hundred thousand kilowatts—at most one million. Although it is true that they constitute a reserve sufficient to fix a quantity of nitrogen corresponding to a very large part of the present European consumption of nitrates and ammoniacal salts, still they would not be sufficient to meet the larger consumption which we may consider as a certainty in the near future.

Our attention is therefore attracted to the problem of economical production of energy by means of motors, employing in some form or other (vapors, poor gases, etc.) coal power. The progress made in this branch during the last 20 years has been so considerable that we may contemplate its future with confidence.

In this respect, the important industrial researches of Dr. L. Mond, seem to me to have indicated the fundamental principles by means of which electric energy will certainly be furnished in the future to the electro-chemical industry in countries which do not possess hydraulic power. These methods, based on the recuperation of nitrogen, are doubly interesting in connection with the subject which is occupying our attention. It is, therefore, indispensable that we should pause here for a few moments, less in order to fix the details with which you are already acquainted, than to emphasise the immense future which awaits these processes; and here let me express my thanks to Dr. Mond and to Mr. Emile Mond, managing director of the Power Gas Corporation, to whom I am indebted for several of the following particulars.

Dr. Mond's system consists in producing gas from gas-producers under conditions which permit the recovery in the form of ammonia of the great part of the nitrogen contained in the fuel and in utilizing afterwards this gas in gas engines, which, in their turn, drive dynamos.

In the case of especially powerful producers, moist air is passed through the incandescent coal (up to 2½ tons of water per ton of coal). This operation ought to be conducted at not too high a temperature. After the gases have been scrubbed in appropriate apparatus, from 60 to 70 per cent. of the nitrogen

contained in the coal is extracted as ammonia; this represents on the average 40 kilos. of ammonium sulphate per ton of coal.

This system is applicable even to combustibles of very inferior quality. The calorific power of the fuel being approximately 6786 cal., the heating power of gas would be 77 per cent. of that of the coal.

From the economical point of view, these most remarkable results may be interpreted by one or other of the following possibilities:

(a) Either the combustible gas is reckoned at the ordinary price of general production; in which case the cost price of sulphate of ammonia amounts to $20 per ton.

(b) Or we may deduct the profit arising from the sale of ammonium sulphate from the cost price of the motive power generated by gas engines; a fact which is distinctly in favor of the gas engine.

If we apply the preceding data to the average conditions in Europe for the production of electric energy in power stations producing several thousand h. p. by gas engines, and if we reckon at $70 per electric h. p. year would amount to about $15 with fuel at $2.50 a ton.

The industrial Mond-gas plants which have been built in England realize conditions very similar to those which we have just indicated. The price per h. p. (electric) is, I undrestand, approximately $14 a year, with fuel at $1.75 a ton.

If we apply this last figure to the cost price of electro-chemical nitric acid, as we have already estimated it, the latter would amount to $65 a ton; in which the fixed nitrogen would be 32¢ the kilo. This is about the price of the Chili saltpetre nitrogen; it leaves, on the other hand, a very interesting margin for the production of nitric acid.

If we take into consideration the enormous advantages which the chemical industry will gain in manufacturing these products in the neighborhood of centres of consumption, we shall be able to appreciate without difficulty the great interest attaching to the development of these methods.

Their importance is still further enhanced by the possibility of producing ammoniacal salts in enormous quantities if we remember that the world's consumption of coal is now not far from one million million tons a year.

It is scarcely necessary to add that this production of ammonia will furnish the electro-chemical nitric acid industry with facilities for producing ammonium nitrate at a low price. This latter, among all the nitrogenous bodies destined for agriculture, is the one which is best adapted to long distance transport, thanks to its high percentage of nitrogen. At the same time it is the nitrogenous fertilizer par excellence.

The following table shows the percentage of nitrogen contained in the various nitrogenous bodies under consideration:

	Nitrogen per cent.
Sodium nitrate	16.5
Ammonium sulphate	21.2
Guano	10-15
Calcium cyanamide	14-20
Calcium Nitrate	17.1
Basic calcium nitrate (Norway)	13-14
Nitric acid HNO_3	22.2
Nitric acid of 95 per cent	21.1
Ammonium nitrate	35.0

Such are, gentlemen, the different prospects of the near future, presented by the problem of the fixation of nitrogen. To what degree and how soon will they be realised? That is a question difficult to answer. Although the value of numerous figures which I have given is rather comparative than absolute, it remains an indisputable fact that at the present day this branch is really and effectively open to industrial methods, which will shortly assure the civilized world of a supply of nitrogen which it will no longer be able to extract from the exhausted reserves in Chili.

The principal part of the nitrogen will be delivered from the atmosphere: electro chemistry now being in a condition to fix this precious element. On the other hand, we can foresee that coal also, which has already proved of such importance in our economical development, will not lag behind in this conquest, to which, furthermore, contributions will certainly be made by rational methods of liquefying air and so separating its elements. Final success is, in a word, dependent on the expansion and development of the most modern discoveries of science and of applied chemistry. It is on this final success that the future of the civilized world depends, and I think, gentlemen, that these considerations are sufficiently important to attract and hold the attention of your Society.

I should like to add my cordial thanks to the Society for having given me the opportunity of bringing before them a problem which has occupied my attention for the last ten years.

Commenting on the discussion, which followed, Prof. Guye says: As to the Chili deposits, data with which I have been furnished, confirm the views which have been stated tonight, namely, that the cost of extraction is now higher than formerly, and that no drop in the price of Chili nitrate is likely to occur.

Experiments with the practical application of calcium cyanamide were made at the college of agriculture at Komaba, To-

kyo, the results of which were published under the names of R. Inamura and K. Aso. A. S. gives the following abstract from their bulletin: Calcium cyanamide is an alkaline manure since, on decomposition in the soil, it yields calcium carbonate and ammonia, the latter in turn being soon transformed into ammonium carbonate. As ammonium sulphate, though of neutral reaction, is physiologically acid, it appeared probable that the most suitable conditions for obtaining satisfactory results would be different with the two compounds, and accordingly the efficacy of mixtures of calcium cyanamide with the acid double superphosphate and the neutral disodium phosphate respectively, was determined. The best results were obtained with the superphosphate mixtures, whereas in the case of ammonium sulphate, the neutral disodium phosphate mixtures are superior to those containing double superphosphate.

Comparative experiments on rice ("upland" and "paddy"), sesamum, and hemp with calcium cyanamide (19.2 per cent. of nitrogen), Chili saltpetre and ammonium sulphate, showed that in general the cyanamide gave rather better results than equivalent quantities of the sodium nitrate and ammonium sulphate. The only unsatisfactory result with cyanamide was in the case of paddy rice on a soil rich in humus, and of a similar character to moor soils, which have been shown by Tacke and Feilitzen not to yield such satisfactory results with calcium cyanamide as other soils do. E. E. H.

SUGAR GROWING IN THE WEST INDIES.

The following review of the efforts of the Imperial Department of Agriculture for the West Indies is contained in a letter addressed by Sir Daniel Morris, K.C.M.V., D.Sc., etc., to the Secretary of State for the Colonies, forwarding a report on the Department, which has been published as Colonial Reports—Miscellaneous, No. 36:

Barbados, January 31, 1906.

Sir: I have the honor to submit a report on the working of the Imperial Department of Agriculture in the West Indies.

The Department was created in 1898, on the recommendation of the West India Royal Commission. This Commission consisted of Sir Henry Norman, G.C.B., G.C.M.G., C.I.E., Sir Edward Grey, Bart., and Sir David Barbour, K.C.S.I., K.C.M.G.

It was charged to inquire into the condition and prospects of the sugar-growing colonies in the West Indies, and to suggest such measures as would appear best calculated to restore and maintain the prosperity of those colonies and their inhabitants.

A further subject of inquiry was whether, in the event of the production of sugar being discontinued or considerably diminished, other industries, and what, could replace it and be carried on profitably and supply employment for the laboring population.

In their report, presented in August, 1897, the Commissioners stated that, "In most of the West Indies the products of the sugar-cane, though they are now valued at prices which are much below those which prevailed a few years ago, still form the larger portion of the total exports of native produce.

"The gravity of the immediate danger to the welfare of each colony, which would arise from a failure of the sugar-cane industry, may, for practical purposes, be measured by the proportion which the exports of sugar, rum, and molasses bear to the total exports of that colony. In such an event, the welfare of each colony would, in the long run, however, depend on the extent to which it might be found possible to establish other industries."

The funds for the maintenance of the Department have been provided since 1898 by a yearly grant by Parliament. The average amount expended has been at the rate of £17,400 per annum, allotted approximately as follows: Salaries and incidental expenses (Head Office), £5,000; grants-in-aid, £12,400.

In Barbados and in the Windward Islands (Grenada, St. Lucia, and St. Vincent) and the Leeward Islands (Dominica, Montserrat, Antigua, St. Kitt's, Nevis, Anguilla, and the Virgin Islands) the grants-in-aid have been expended in the maintenance of botanic and experiment stations and agricultural education; in Jamaica, in providing the services of an agricultural lecturer; in British Guiana, in assisting experiments in improving the sugar industry; and in Trinidad (for Tobago), in maintaining a botanic and experiment station.*

The Imperial Commissioner is directly in charge of the administration of the agricultural grants at Barbados and in the Windward and Leeward Islands, and is consulting officer in agricultural matters to the Governments of Jamaica, British Guiana, and Trinidad.

The duties entrusted to the Department were the general improvement of the sugar industry and the encouragement of a system of subsidiary industries in localities where sugar cannot be grown, or where the conditions are more favorable for the

* The grants-in-aid of Jamaica, British Guiana, and Trinidad (for Tobago) were withdrawn on March 31, 1906.

production of cacao, coffee, bananas, limes, cotton, rubber, cocoanuts, sisal hemp, rice, nutmegs, pineapples, and other crops.

In addition, it was proposed that it should devote attention to the improvement of the breed and condition of cattle, horses, and small stock, and to the extension of bee keeping for the production of honey and bees'-wax.†

As it was realized that substantial progress was impossible until the mass of the people (wholly dependent on the products of the soil) were brought into sympathy with agriculture and trained to regard the sucessful treatment of crops as the basis upon which to build, not only their own welfare, but the general prosperity of these colonies, a prominent position has been given to teaching the principles of elementary science and agriculture, both in the primary and secondary schools.

Associated with this policy was the increased attention devoted to object-lessons, the encouragement of growing specimen plants in pots and boxes, and the establishment of school gardens. Arbor days for the public planting of ornamental and other trees have also been organized and assisted by the Department.

The details of the working of the Department have been regularly presented and discussed at the several West Indian Agricultural Conferences, at which the officers of the Department and the representatives of the Agricultural and Commercial Societies and of the several educational bodies in the West Indies have taken an active part. The proceedings of these Conferences have been published in full in the *West Indian Bulletin* and the *Agricultural News*.

SUGAR INDUSTRY.

In British Guiana, Barbados, Antigua, St. Kitt's, and Nevis sugar is the staple industry, and upon its success depends the welfare of the inhabitants and the resources of the Governments. In Trinidad and Jamaica sugar, it is true, occupies a secondary position, but it would seriously affect both these colonies if the industry were further reduced or abandoned. Other islands in which sugar is grown to a greater or less extent are Tobago, St. Vincent, and Montserrat. In Grenada and Dominica practically little or no sugar is produced.

The Imperial Department of Agriculture has devoted special attention to the scientific investigation of questions affecting the sugar industry. The average expenditure in this direction in Barbados, Antigua, St. Kitt's, and British Guiana has been at the rate of nearly £4,000 per annum. The investigations have been mainly directed to raising new seedling varieties of sugar-canes,

† The annual value of the bee-keeping industry in Jamaica is about £17,000.

capable of withstanding diseases that rendered the continued cultivation of the Bourbon and allied canes impossible, and raising standard varieties capable of producing a larger yield of sugar per acre. Valuable experiments have also been carried on, over considerable areas, in testing the relative value of pen and artificial manures, and in ascertaining, by a continuous series of trials under skilled supervision, in what quantities and at what stages of growth of the canes such manures can be applied to the best advantage. In addition, investigations have been carried on in the chemical selection of the sugar-cane, in the treatment with germicides of cane tops, and as to the effect of planting at different distances and tillage operations.

In all these directions the results already to hand are of a striking character. The following is a brief summary, in continuation of the valuable information presented by the several officers directly in charge of experiments at the Agricultural Conference held at Trinidad in January, 1904.

BRITISH GUIANA.

The total area under cultivation in sugar-cane in British Guiana is 78,003 acres, including 2,500 acres cultivated by small farmers. This is an increase of 11,095 acres as compared with 1896. The average cost of producing 1 ton of first centrifugal sugar, including 14 per cent. second sugar and 25 gallons of rum, was £10 9s. 2d. in 1903, as compared with £11 9s. 2d. in 1896. In 1897 only small areas of land were occupied with canes of other varieties than Bourbon, while at the present time about 14,000 acres are planted with them.* The results of experiments on a large scale with seedling and other canes than Bourbon recorded during the last three years "indicate an increased yield per acre of from 12 to 20 per cent. over that of the Bourbon." The Sugar-cane Committee of the Board of Agriculture states that this increase has been obtained by the substitution of certain new varieties for the Bourbon cane "without increase in the cost of cultivation and possibly with lessened outlay for manure." It is added that "in many of the experiments the varieties, other than the Bourbon, have been cultivated on land on which the latter cane does not flourish, while the Bourbon returns are, as a rule, from land of average fertility, upon which it gives satisfactory returns."

The following are the principal varieties of canes other than Bourbon cultivated in British Guiana: D. 109 (3,338 acres),

* In a report issued by the British Guiana Board of Agriculture on June 5, 1906, it is stated that 21,481 acres are now occupied with varieties other than Bourbon—an increase of 45.7 per cent. on the acreage in 1905-6. —[Ed. W. I. B.]

White Transparent (2,876 acres), B. 147 (1,138 acres), D. 625 (537 acres), and B. 208 (417 acres).†

As confirming what is stated by the Sugar-cane Committee, and as showing what has been done with seedling canes on a large scale at the Diamond estate, in British Guiana, the manager states, as the result of experiments carried on for four years (1901-4 inclusive), that seedling canes grown on an average area of 1,537.918 acres, as compared with Bourbon canes grown on an average area of 2,824.352 acres, have proved better than the Bourbon to the average extent of 24 per cent.‡ The average crop reaped during the period under review was 10,560 tons of sugar.

BARBADOS.

In Barbados, during the last five years, 20,407 varieties of seedling canes have been raised. Less than 1 per cent. of these have stood the stringent tests of field and chemical selection applied to them. The seedling experiments in hand up to December 31, 1903, consisted of 8,120 plots, covering 143.294 acres. Experiments with manures consisted of 106 plots, covering an area of 14.196 acres, while another set of manurial experiments consisted of eighteen plots, covering an area of 16.02 acres. The general results are favorable, and indicate that the efforts that are being made are in the right direction and justify the opinion that the raising of seedling canes affords special promise, as in British Guiana, of increasing the yield, and diminishing the cost of cane sugar production in this island.

About 35,000 acres of canes are reaped annually in Barbados. According to a return prepared by Mr. Bovell in 1903, the Bourbon cane, owing to the prevalence of disease, has been almost entirely discarded of late years. The area under cultivation in this cane in 1903 was 328 acres. The area under other canes in 1903 was approximately as follows: White Transparent, 18,566 acres; Rappoe, 3,089 acres; Caledonian Queen, 1,661 acres; B. 147, 1,642 acres; B. 208, 342 acres. The area under seedling canes is gradually extending. The figures for 1904 are not yet available. Of the newer canes, the most promising is B. 1,529. The cultivation of this cane (on account of the large yield per acre and the purity of its juice) is being extended to as many experiment plots as possible during the present planting season.

† The same report gives the acreage occupied by the principal varieties other than Bourbon for the crop 1906-7 as follows: D. 109 (8,386 acres), D. 625 (3,357 acres), B. 208 (2,125 acres), D. 145 (1,842 acres), B. 147 (1,733 acres), and White Transparent (1,416 acres).—[Ed. W. I. B.]

‡ More recent returns, published in the *Agricultural News* (Vol. V, p. 99), show that "the average superiority of seedling canes over the Bourbon cane on plantation Diamond, over a period of five years, is at the rate of 25.6 per cent."—[Ed. W. I. B.]

In presenting the report on the experiments carried on at Barbados during the crop seasons 1903-5, Messrs. d'Albuquerque and Bovell called attention to new seedling canes, still under trial, such as B. 1,753, which had given saccharose at the rate of 11,516 lb. per acre; B. 3,289, at the rate of 10,705 lb. per acre; B. 1,030, at the rate of 10,485 lb. per acre; B. 1,355, at the rate of 10,302 lb. per acre; B. 6,048, at the rate of 10,102 lb. per acre; B. 3,696, at the rate of 9,828 lb. per acre; while the White Transparent (the cane now generally cultivated in the island) for the same two years had given 6,452 lb. of saccharose per acre only. The glucose per gallon of the new canes was also satisfactory.

Referring to B. 147, it was stated that, on one estate during the crop season 1903-5, this cane, as a plant cane, had given 320 lb. per acre of merchantable sugar more than the White Transparent. On the same estate there had been reaped as ratoons during the two years an average of 44 acres of B. 147, and this cane had given 599 lb. more saccharose per acre than the White Transparent.

In regard to the manurial experiments at Barbados, the results confirmed those obtained in previous years. They indicated that an ordinary application of farmyard manure, together with artificial manure, was more effective than a very large application of farmyard manure without artificial manure; also that the application of nitrogen, both to plant canes and to ratoons, was followed by a profitable increase in the yield. The application of sulphate of potash was generally profitable. On the other hand, phosphatic fertilizers either had no effect upon the yield or caused a diminution.

LEEWARD ISLANDS.

In the Leeward Islands Dr. Francis Watts has recently presented the results obtained during the last five years in regard to the introduction of seedling canes and manurial experiments at Antigua and St. Kitt's.

In Antigue there are about 8,000 acres under cane cultivation. The principal varieties are the White Transparent (under which is included Naga B., Mont Blanc, and Caledonian Queen), B. 147, D. 95, and B. 208. The area under Bourbon is reduced to about 204 acres. By means of the introduction of new varieties of canes, Dr. Watts states, "the planter has now an opportunity of selecting his canes for particular soils and situations or for early or late planting. In this way he may not necessarily select that cane which has done best on the average of the whole of the experiments, but his own observation may have led him to see that some particular cane will prove suitable for some special conditions, and he selects suitable canes accordingly."

At St. Kitt's, the total area under canes is estimated at 7,000

acres. The principal canes cultivated are what are known as the "Jamaica," Caledonian Queen, and White Transparent. The area under seedling cane B. 147 is about 1,700 acres, and under B. 208, 130 acres. The area under Bourbon is about 340 acres.

At one time cane diseases in this island "invaded one area after another until fears were entertained that some estates must be abandoned, and sugar-growing cease upon them. Following the advice of the Department of Agriculture, those planters, whose canes were being destroyed by the ravages of disease, introduced other varieties, notably B. 147, with the happiest results; plantations which were in danger of abandonment are now bearing luxuriant crops, to the great relief and satisfaction of their owners."

In summing up, Dr. Watts states: "It will be seen that the newly-introduced varieties of canes, including some of the newly-discovered seedlings, have already played an important part in the sugar industry of the Leeward Islands. The work of their introduction is highly regarded by planters who freely express their appreciation of the advantages they have derived, and the feeling is now engendered that in the selection of varieties of cane they are in possession of a powerful defence against many forms of cane diseases."

In a report on the condition of the sugar industry in Antigua and St. Kitt's during the period 1881-1905 (dated November 29, 1905), Dr. Watts states:

"The stability given to the sugar industry by the abolition of bounties by the operation of the Brussels Convention has already led to a considerable amount of development in the sugar industry in Antigua in the past two years. The erection and successful operation of the Central Sugar Factory at Gunthorpe's at a cost of £45,358, the conversion of Bendal's sugar factory into a small but well-equipped modern factory at a cost of some £12,000, together with the extensive substitution of railway and tramway haulage for less perfect methods at both these factories, indicate a desire for progress such as has not been seen in the smaller islands for a generation or more, and is good evidence of a determination to do the best to make the industry successful.

"Nor does the tendency towards progress end here. Two sets of steam-plowing plant are expected to arrive in Antigua within the next few weeks, one set being imported for working the lands associated with each of the above-mentioned factories; these, by deeper cultivation of the soil, are calculated to minimize the effects of drought. Concurrently with this, we may expect other improvements, all of which must have their effect on the production of sugar and upon the welfare of the island.

"We are therefore justified, I think, in making some forecast of the future, and may reasonably hope to see the sugar crop in Antigua, not only reaching to, but, by virtue of the improvements

now introduced, exceeding, the crops of the period 1881-94; that is, exceeding, on the average, 13,000 tons. The price of sugar will doubtless be low, but at £8 per ton, at which price in an average year sugar can be produced at a small profit, this is worth £104,000, while doubtless there will be a steady increase in the amount of crystal (vacuum pan) sugar produced and a diminution of muscovado, thus increasing the value of the output. In addition to this, we may look forward to those developments which are sure to arise when the planting body is stimulated to a degree of activity exceeding anything which has existed in the past. Increased areas and improved methods of cultivation, improved varieties of canes, and various other improvements, such as may be anticipated from the intelligent working of a well-equipped Department of Agriculture and active and alert planters, cannot fail to result in beneficial changes."

TRINIDAD.

In Trinidad the Otaheite or Bourbon cane is generally cultivated. Owing to the absence of serious disease and to the generally good results obtained from the present canes, systematic experiments on a large estate scale with seedlings and manures have apparently not been regarded as a necessity, as in the other colonies. Seedlings raised locally, or obtained from elsewhere, have been grown on a small scale at the St. Clair Experiment Station, and the canes analysed by the Government Chemist. The results have been published in the *Proceedings* of the Agricultural Society and the Annual Reports issued by the Botanical Department.

As a result of an experiment with a seedling cane (D. 95), as compared with the Bourbon and White Transparent canes, carried on by the Trinidad Estates Company under the direction of Dr. A. Urich, the following figures may be of interest:

RECAPITULATION (TONS OF CANE PER ACRE).

	Plants	1st Ratoons	2nd Ratoons	Average, actual	Acres cut
Bourbon	21.05	16.42	15.34	16.43	604
White Transt.	27.53	19.88	15.15	22.35	935
D. 95	32.85	20.68	20.88	23.65	225

At Caroni estate, Trinidad, what is known as the Naudet patent process of extracting and purifying cane juice was on trial during the season 1904-5. The results were short of expectations, owing to the defects in the first milling, the cane not being opened up sufficiently to give good diffusion results. It is, however, claimed that there was a gain over double milling. At Porto Rico

the results were more favorable: "The extraction was 96 per cent. of the total juice in the cane, with a dilution of 9 per cent. on the weight of the cane, and the density of the juice from the diffusion battery was only 0.7° Beaumé less than the juice from the mill. This juice was also of equal purity to the juice from the mill."

JAMAICA.

A law was passed by the Legislature of Jamaica in August, 1903, by which the Imperial grant-in-aid of the sugar industry (£10,000) was appropriated for the maintenance, under the direction of Mr. Cousins, of experimental stations, with special reference to the chemistry and mycology of sugar and rum. A Fermentation Chemist has been appointed in connection with the rum investigations. The grant is estimated to provide for research and experiment work for six years.

In regard to seedling canes, Mr. Cousins states that the best of the seedlings from Demerara and Barbados have been carefully tested in Jamaica. Two of these stand out in a prominent manner. "Barbados seedling No. 208 appears to be well suited to all parts of Jamaica, and is probably the best cane now available. At the Hope Experiment Station in 1905 a crop of this variety was harvested, yielding over 70 tons of cane, capable of yielding 7 tons of sugar per acre. Upon light soils in seasonable or irrigable districts, Demerara seedling No. 95 has proved a great success. This cane has given double the yield of crystallized sugar per acre, as compared with the Jamaica cane, and upon a commercial scale under these conditions."

Further, "there are districts in the island where the seedling canes already at our disposal are capable of giving a return of at least 30 per cent. more sugar per acre than the Jamaica cane. The seasonable and irrigable areas should benefit with certainty from carefully controlled trials of the most promising seedling canes now in cultivation. Estate trials of ten varieties, specially selected for local conditions, have been arranged on twelve estates."

As to experiments in manuring canes, Mr. Cousins states: "Results already obtained show that considerable agricultural returns can be obtained in the cultivation of canes by the use of lime or marl on soils not deficient in humus and nitrogen, by the judicious use of fertilizers where the water supply enables large crops to be grown with some certainty, and, lastly, of the great effect of drainage upon stiff, flat areas of land. It is proposed to extend these experiments, to carry them out with stricter oversight and control, and to aim at the financial demonstration of the results of the operations under test."

Proposals are in hand for establishing two central sugar fac-

tories in the district of Vere, and another in the neighborhood of Montego Bay. There is also a prospect of improving the rum industry in Jamaica, based on recent investigations carried on by Mr. Cousins.

PEDIGREE SUGAR-CANES.

An important step in advance was made by the Department in 1902 in the hybridization of the sugar-cane, and in raising new seedling varieties by artificial cross-pollination. The details are given in the *West Indian Bulletin* (Vol. VI, pp. 394-402) and in an article under the heading "Raising Pedigree Sugar-canes" in the *Agricultural News* (Vol. V, pp. 17-8). Some of the new pedigree canes thus obtained are now under cultivation. If, as anticipated, the results of the new method of breeding sugar-canes above referred to are still further extended during the next few years, the prospects of the sugar industry in these colonies should be still further improved. There are now no good reasons why we should not be in a position to produce pedigree sugar-canes as well as pedigree wheat and oats. The work carried on by the Department in raising new seedling canes is closely followed in all sugar-producing countries. According to the Director of Sugar-cane Experiments at Hawaii, the Demerara seedling No 117 yields from 1 ton to 1½ tons more sugar to the acre than any other variety under trial. In Louisiana the best canes in experiments carried on by Dr. Stubbs were seedling canes D. 95 and D. 74. The Barbados cane B. 147 has given excellent results in Queensland, while another Barbados cane (B. 208) is reported to have given 69 tons of canes per acre, with 22.2 per cent. of sucrose.

In Jamaica, according to Mr. Cousins, the same cane under irrigation gave 66.5 tons of canes per acre.

It may be added, as an instance of what takes place in one island, that over 20,000 plants (tops and portions of stems) of new seedling canes are annually exported from Barbados to other parts of the West Indies. The area under seedling canes is steadily extending, and it is hoped that a general improvement of the sugar industry will thus result from the conjoined efforts of the Department and members of the planting community.

In concluding this summary of the efforts that have been made to improve the condition of the sugar industry in the West Indies, I desire to place on record my deep appreciation of the valuable assistance that has been afforded to the Department by the proprietors, attorneys, and managers of estates.

It was laid down as an essential feature of the experiments with sugar-cane that the canes should be cultivated on the experiment stations in exactly the same manner as the ordinary crop on the estate, so as to institute a close comparison on the

most practical basis between the new seedling canes and those ordinarily grown.

In Barbados, Antigua, St. Kitt's, and Nevis about 200 acres of cane land have been placed at the disposal of the Department for the purpose of experiments, and all expenses of cultivation, and, in some cases, of manures also, have been borne by the estates. A similar coöperation between the officers in charge of experiments and the planters has also obtained in Jamaica and British Guiana.

Whilst steady progress is being made in raising new canes and in the selection and use of manures, the methods that have been adopted for extracting the juice and manufacturing the sugar, except in a few instances, at Jamaica, Barbados, Antigua, Montserrat, St. Kitt's, and Nevis are still far from satisfactory.

Up to 1903, owing to the existence of the continental bounties, the sugar industry in the West Indies had lost its credit, and since the bounties were abolished, sufficient time has not elapsed to enable capitalists to estimate what the effects are likely to be. It is evident, however, that the work of raising new canes, capable of withstanding disease and of yielding an increased amount of sugar, does not cover the whole ground, as until improved machinery for extracting the juice and manufacturing the sugar is in general use in the islands named, it will be impossible for them to compete successfully with other sugar-producing areas.

In the evidence placed before the West India Royal Commission at Barbados, it was stated that there was "an average loss of over 2,000 lb. of sugar per acre left in the canes after crushing, which was burnt in the megass;" and again "for every 100 lb. of crystallizable sugar contained in the juice, not more than an average of 75 lb. of ordinary muscovado sugar was recovered."

At present it takes about 13½ tons of canes to produce a ton of muscovado sugar of the value of £8; while in a well-equipped factory it would only take about 9½ tons of canes to produce a ton of grey crystals, of the value of about £10 10s. It is also to be borne in mind that muscovado sugar is only in limited demand in the United States and Canada, while grey crystals are readily sold in any quantity.

The establishment of a central factory in Antigua and the publication of the results of working during the first year (1905) have already produced a favorable impression in favor of central factories. The opinion is becoming general that the sugar industry cannot be maintained under existing conditions and that the only possible means of improving it is by the establishment of central factories.

The Royal Commission recommended that, in the case of Barbados, money should be lent by the Home Government for the purpose of establishing central factories, and that "if the scheme

succeeded, it might be extended in Barbados and possibly in the other islands."

The circumstances in most of the other islands referred to are very similar to those in Barbados. The Hon. F. J. Clarke, president of the Barbados Agricultural Society, in a paper read before the West Indian Agricultural Conference in 1900, expressed his opinion as follows: "Not only must we have central factories in order to avoid the enormous loss attending the present system of manufacture by means of small and imperfect crushing machinery and open tayches, but to be able to manufacture any class of sugar that may be in demand in the markets of the world." Further, he stated: "It is absolutely essential to our existence that central factories should be erected here." Professor Harrison, with his long experience of Barbados and his more recent acquaintance with the working of central factories in British Guiana, at the same Conference stated: "There is not the slightest doubt in my mind that, if this colony of Barbados is to continue to exist as a sugar-producing colony, it must adopt the principle of central factories." And further: "All I can say is, that I believe the erection of central factories in Barbados would be a means of raising the colony out of its present difficult position and, in fact, prove its salvation."

Exactly similar remarks apply to Jamaica, St. Vincent, Antigua, Montserrat, St. Kitt's, and Nevis, in all of which the sugar industry might be greatly extended and improved.

THE AGRICULTURAL LANDS OF THE HAWAIIAN ISLANDS AND THEIR PROBLEMS IN COMPARISON WITH AMERICAN STANDARD.

By L. E. Pinkham.

(Read before the Honolulu Engineering Association at its July, 1906, meeting).

Omitting the cotton and tobacco plantation agriculture of the Southern States, we will consider the individual American farmer, to whom we attribute the basic development of the United States on what is termed American lines.

The original American farmer resided in the Atlantic States and was a man with the hardihood and patience to clear his land of timber and stones; he was also the man with an axe, a spade, a plow, a harrow, a hoe, a seed-bag, a sickle, a scythe, a pitch-fork

and a flail, all wielded by his own muscle during hours limited only by human endurance. His fields were small; his livestock few. Every member of his family was a working factor as soon as physically able.

He was a man of strictest economy, plain living, plain thinking, fearing God, respecting the rights of men and not misled by sophistry.

Unable to maintain on his farm a matured family, usually numerous, his children generally sought employment, business or professional opportunities, or joined the movement toward western agricultural lands, though filial duty and inheritance kept a few at home. Eventually the competition of the favored West compelled the abandonment of many farms.

Although maintaining high intelligence and personal and civic character, this American farmer was absolutely *"The man with the hoe."*

The wave of a mighty change began to sweep over the country. The construction of numerous railroads, running hundreds of miles ahead of population, the wonderful adaptability of the topography of the country between the Alleghany and Rocky Mountains, the untold millions of acres of land all ready for the plow, and the wise and liberal land policy of the United States Government and the Land Grant Railroads, made possible the rapid development and vast increase of the modern American farmer. He was recruited, not alone from native sources, but from the best strains of European national blood and character, which strengthened, rather than weakened, the nation.

Infinitely more than anything else, the marvelous and numerous inventions of comparatively inexpensive farm machinery lifted him from exhausting physical drudgery and mental depression, and made the American farmer of today. Without these inventions American agriculture could not have thriven, nor could the prosperity and character of the American farmer have been built up.

The American farmer now rides to plow, rides to harrow, rides to sow, rides to cultivate, rides to mow and reap, rides to harvest, and, with power, stacks and houses his crops. Creameries make his butter and cheese. Cold-storage preserves his perishable products. He slaughters no animals, he ships them. Hygienic care and scientific feeding have made 40 to 50 pounds of corn equivalent to 100 pounds as fed twenty years ago. The incidents of progress are too numerous to mention. The farmer's condition is the result of applied science, agricultural economics and transportation.

The American farmer is rich and independent beyond any division of men of physical activity in the world.

Twenty-seven years ago, even to save a crop, these farmers absolutely refused to return and wield the hoe, even for a few days, when, for a continued wet period, the fields were impassa-

ble for animal cultivation. Eventually, they tile-drained their fields and thereafter could cultivate at will.

Hired farm help is becoming scarce and exacting. He demands liberal leisure and special social consideration. In some instances, he is demanding more than economic conditions can admit.

The *American farmer* of today is *"The man with machinery,"* and he will so remain until congestion of population, scarcity of land and necessity force him to retrograde.

I witnessed much of the great wave of immigation that swept over the western areas of Iowa and Missouri, and over Nebraska and Kansas.

The land policy of the Government and Land Grant Railroads had been fixed, surveys made and millions of acres of arable land, ready for the plow, with suitable seasons, rainfall, water supply and transportation, awaited settlers.

The great majority of immigrants knew exactly whither they were bound and almost their exact locations.

The immigrant was not obliged to waste his substance, time, patience and hope waiting for a land policy to be adopted, surveys to be made, or halting official minds.

The Government fixed 160 acres as the maximum grant to one person, until later, to forest some of the vast treeless States, a grant of 160 acres additional could be taken under stipulations as to planting trees. The price of these lands was fixed at from $1.25 to $2.50 per acre.

The Land Grant Railroads sought the immigrant, not to secure a high price for land, but to get the land to producing freight. These lands were sold on long time at from $5.00 to $10.00 per acre.

Every 80 acres of Nebraska corn-land that produced and shipped thirty-five bushels to the acre, furnished freight that paid $403.00 for transportation to Chicago, and a total of $877.80 to $1,022.20 if shipped to New York or New England. These were the rates of the years 1879 and 1880.

This was a great annual stake to play for and the unparaleled fortunes made show the railroads acted with the greatest business acumen for their stockholders.

To again refer to the chief factor of the uplifting of American agriculture, *farm machinery*, we will turn back to the Atlantic States and to the Connecticut River valley, a place familiar to the writer as his home for the first twenty-two years of his life. This valley was the seat of raising the then unequalled Connecticut seed leaf wrapper tobacco. Though a cotton manufacturer's son, I took great interest in observing the eight acres of the highest cultivated field in America. Invention has completely captured this field of growing tobacco, as an extract from a recent communication will show, as follows:

"The work of transplanting the tobacco crop began in earnest this week. Probably 90 per cent. of the tobacco put out this year

will be set by machine, which has almost superseded the old method of hand transplanting. Three men and a pair of horses with a machine will transplant from three to four acres a day, where, by the old method, the same gang could hardly have set out an acre. Before the advent of the machine, the farmer who raised 10 acres of the weed was considered a large grower, but today there are scores of growers who put out 20 to 25 acres; some 30 to 35 acres, and the syndicates 75 to 125 acres. All the way through, modern farm machinery has made it possible to do the greater part of the farm work with horses. The farmer no longer walks; he rides. And best of all, he 'gets by,' and today enjoys as necessities what, fifteen years ago, would have been extravagant luxuries."

I can assure you that forty years ago these same farmers, in this particular locality, were handsomely equipped in homes, barns, carriages, etc., and enjoyed social culture and privileges, supported an academy larger than Oahu College, and possessed churches finer than our own, except, possibly, the Central Union.

AMERICAN LAND HUNGER.

In the growing West, land hunger was intense. Shrewd youths and maidens deferred marriage and each took up 160 acres of farming land and 160 acres of timber claim land, and, as soon as the law permitted, joined hands with 640 acres of land as their foundation for the future. A farmer of large landed possessions refused, for three years, to pay a note due me, as he said, "Land will be getting scarce and I must have that 640 acres in the next township."

Mr. R. H. Chamberlain, of this city, and myself were formerly acquainted with Mr. David Rankin, of Tarkio, Missouri, the largest corn farmer in the world, who owns about 30,000 acres of land, nearly every acre being cultivable and worth $100.00. I knew Mr. Rankin when he first began to transfer his interests from the Mississippi to the Missouri River valley and started to acquire this great landed estate. This simply fixes the fact that land in the United States is not as sub-divided as is represented. Mr. Rankin can crop yearly, should he choose, one-fifth to one-quarter of an area equal to that annually cropped by the entire sugar plantations of this Territory.

AMERICAN LAND POLICY.

The only restriction in the United States against the acquiring of land was against foreign non-residents, who would, if allowed, have secured little empires.

The American farmer stands on his right to do as he chooses with, or to dispose of, as he will, his lands. He stands or falls on his own ability, and not on Government regulation or dictation. To change from this *American Land Policy* to a *Paternal Land*

Policy is not American. If a man is fit for American citizenship, he is fit to exercise independence in his private affairs. When the Government chooses to part ownership of any of its lands, it should "let go the apron strings" and let her citizens become independent men and not wards. We, in Hawaii, must come to this or there can be no *"Development on American Lines."*

AGRICULTURE IN THE HAWAIIAN ISLANDS.

Not in all history, nor in any part of the world, have there been agricultural operations, on an equal area, that can approach, either in daring, cost of plant or results, those of the sugar plantations of the Territory of Hawaii.

Over eighty per cent. of the available arable lands of the Hawaiian Islands require artificial irrigation. If there were included the arable, but hopelessly waterless, lands of Molokai, Lanai and Niihau, the percentage would be nearer ninety than eighty per cent.

In 1904, the production of sugar constituted 96¾ per cent. in value of all our agricultural produce, and, in 1905, about 98 per cent.

Therefore, in order to understand the agriculture of these Islands, we must understand the sugar situation, for, other than sugar, there is in sight no possible support for the population or the Government.

There are 568,000 acres of arable land in the Hawaiian Islands, of which 12,053 acres were appropriated to rice culture, 199,460 acres were planted to cane, and there are about 40,385 acres additional that may be, eventually, planted to cane. The remainder, 317,102 acres of arable land, will be discussed under the heading "Small Farming" at some future date.

The 239,366 acres of sugar lands we will separate into their two classes, "Irrigated Lands," comprising 164,876 acres, and "Rainfall Lands," comprising 73,041 acres.

It must be remembered that 42,137 acres of Kohala and Hamakua sugar lands have now come under the designation "Irrigated Lands," and are described in this paper as "Partly Irrigated Lands."

The only basis on which a layman can understand cropping land and its combined physical and financial facts and problems is on the basis of the area annually cropped. Less than one-half the cane-planted area can be cropped in any one year.

I desire to impress upon you the tremendous significance and relative magnitude of the two factors of Irrigation and Transportation as existing in this Territory solely dependent on sugar production. For full details, I refer you to Table No. 2.

That, eventually, an area of 80,196 acres of irrigated sugar land may be annually cropped, every source of water supply on the four producing Islands has been exploited, with scarce an excep-

tion, and a maximum daily supply of 1,684,500,000 gallons has been secured, a quantity exceeding five times that used by the city of Greater New York and its four million inhabitants. The average daily supply is 1,186,700,000 gallons, or nearly four times the consumption of Greater New York. The water supply is still insufficient to irrigate all the cane land directly available.

The water supply ditches are 503 miles in length, of which 71¼ miles are tunnels; the distributing ditches are 717 miles long and will soon approach 1,000 miles. There are 250 storage reservoirs with a capacity of 8,181,750,000 gallons. There are 428 artesian wells furnishing 494,750,000 gallons of water daily, and other underground sources producing 96,450,000 gallons, all of which is pumped through 72 miles of great steel and iron pipe lines by steam pumps, of 26,854 horsepower, to various elevations up to 560 feet. Huge iron siphons, aggregating over twelve miles in length, carry water across great gulches, the deepest carry being 700 feet.

All these and other enormous installations with operating capital have been made at a cost of $70,603,893.49, that, in the year 1905, 59,693 and 63-100 acres of sugar cane might be cropped and that, eventually, 80,196 acres may be cropped annually.

In the Hawaiian Islands, the steam railway mileage, mostly on irrigated plantations, comprises 716⅝ miles, or over three-quarters as much mileage as the State of Connecticut has. By the census of 1900, Connecticut had a population of 908,240 souls against 154,001 souls in the Territory of Hawaii. We do not include our 122¼ miles of movable track. On the 716⅝ miles of Hawaiian steam railways, there are employed 111 locomotives and 8,220 cars. Additional special cane transportation is provided by 379½ miles of flumes and 39½ miles of overhead cableways.

All these means of transportation, costing, with other investments and operating capital, $94,380,617.29, that, in the year 1905, 95,443 and 31-100 acres of cane might be cropped, and that eventually 118,380 acres of cane may be annually cropped.

Can anyone claim that the agriculture of Hawaii is not the most costly in installation and intensive in operation of any existing or historically recorded?

FINANCIAL RETURNS TO THEIR STOCKHOLDERS BY HAWAIIAN SUGAR PLANTATIONS.

Twenty-three of the fifty-three plantations are favorably situated, and are operated under adequate and economical systems of irrigation or under agriculturally correct rainfall. These have been very profitable at times; are almost always reliable dividend-payers and some have paid remarkably well.

Seven others have been profitable at times.

Seven have never paid a dividend.

One has lost its identity.

Fourteen experience occasional prosperity.

In this paper, no note is taken of six disastrous plantation ventures, undertaken since the year 1898 and forced into liquidation.

By adding together the years each plantation has existed as organized, we find up to January 1st, 1905, as follows:

Total years established, including all plantations.....		752
Total years in which dividends have been paid in part..	34	
Totals years in which dividends have been paid in full..	323	
Total dividend years	357	
Total years in which no dividends have been paid.....	395	
		752

The total amount of dividends paid in dollars is unknown to anyone.

The above facts will dispose of the idea that sugar is always and generally enormously profitable and can stand an indefinite amount of political and economic experimenting and exploitation.

It is the fairy-tales spread everywhere, particularly in Washington, that have created beliefs as to the Hawaiian sugar industry in official and labor circles to the everlasting embarrassment of this Territory, all based on reports of the prosperity of plantations specially favored by natural conditions, but entirely overlooking average experience and conditions.

RETURNS TO THE TERRITORIAL GOVERNMENT.

In the year 1902, the Territorial Government received from the plantations a sum in taxes approximating the entire net profits of all the plantations combined.

In the year 1903, the Government received in taxes a sum equal to fully one-third the dividends paid the stockholders. Such a condition could not extend indefinitely.

LAND POLICY OF THE TERRITORIAL GOVERNMENT.

The local Government does not as extensively as imagined control the land situation as regards plantations. From information in possession, the following is a fair review of the situation so far as the sugar plantations are concerned:

On Kauai over two-thirds (2-3) of the lands are leased, quite largely from private holdings.

On Oahu over fourteen-fifteenths (14-15) of their lands are leased, nearly all from private holdings.

On Maui less than one-seventh (1-7) are leased, six-sevenths being owned in fee.

On Hawaii it is difficult to compute the exact facts, but it is doubtful if the Government controls one-third (1-3) of the sugar lands.

This minority holding must have some influence on the general

land situation, but cannot be the determining factor in establishing the agricultural population of the Territory.

On irrigated plantations, there is invested $1,006.82 (exclusive of land) for each acre of cane annually cropped, and altogether $204.58 for each ton of sugar produced annually.

On rainfall plantations, there is invested $501.34 (exclusive of land) for each acre of cane cropped annually, and altogether $257.83 for each ton of sugar produced annually.

As leases expire, the plantations, having brought these lands from a worthless state to one of high cultivation, and their investments being still necessary to preserve its productiveness, have an equity that cannot justly be ignored nor unduly taken advantage of.

The plantations cannot be subject to ignorance, indifference nor erratic agricultural projects, nor should they be subject to schemes to acquire title to lands, on which leases have expired, by persons who aim to neither compensate the Government for the improvements reverting to it, or to personally directly cultivate the land, but aim to force the plantations to finance the working of the land, to directly or indirectly pay the wages from month to month of alien labor, and, in fact practically work the land and pay tribute to proprietors whose residence and responsibility is only nominal.

The moment the Territorial Government attempts to stipulate what a purchaser of agricultural land shall raise on it, when or how he shall exercise his presumably independent rights as a landowner, the Government is out of its province and will break down in the attempt. It is absolutely un-American. It is fortunate the interest of the Government in the cane lands of the Territory is as limited as it is.

There is no parallel in the experience of the American Government, for no highly improved lands have ever reverted to that Government.

The Territory cannot well overlook its own equities and make, in a degree, gifts of improved lands to acquire citizens.

CULTIVATION AND MACHINERY.

The evident policy of the plantations is to force the yield of their lands to the utmost.

A few of the older, conservative owners and scientists have endeavored, unsuccessfully, to bring about a realizing sense that Hawaiian lands are no exception to those of the rest of the world, and, sooner or later, must have a rest or rotation of crops.

From the fact that land is so limited in area, few are willing to cut down the area in cane and probably will not until strikingly diminished yields force the issue.

In the use of such preparation machinery as steamplows, the Hawaiian plantations have led the world.

IMPROVEMENTS IN FIELD MACHINERY AND FIELD METHODS.

From what has been accomplished by invention and the almost unlimited use of novel and efficient agricultural machinery, especially the example of what has been accomplished in that more delicate and difficult agriculture, the raising of tobacco, the Hawaiian planters have a great incentive to seek relief from their labor troubles in discovering field methods and varieties of cane that will admit of the use of machinery throughout field operations. Inventions will rapidly follow practical field conditions.

It may be necessary to revolutionize field methods before machinery can cover the entire field of operations. If the planters can supply their own cheap, convenient and transportable fuel for power in denatured alcohol, one problem is already on the way to solution.

The Planters' Association could well afford to establish a field experiment station of 1,000 to 3,000 acres. The Kohala district would seem a favorable location for such a station.

LABOR.

The sugar crop of 1905 was made by 43,158 persons on the plantations, from the managers down.

There were 6,726 citizens (or eligible) and 36,432 aliens employed.

These cropped for the year 1905, 95,443 and 51-100 acres, or 2 and 21-100 each, producing 427,365 and 68-100 tons of sugar, or 9 and 905-1000 each.

For that crop, the Portuguese furnished 608 high grade employes, 698 common laborers and 1,205 field hands, making a total of 2,511 souls.

We are hoping to secure many immigrants of this desirable nationality.

I fear we are a bit too sanguine, for I hold before you a paper published in the Azores, which I received in April last, and in which you will note is an advertisement, occupying half a page, in which the Argentine Republic advertises for immigrants and settlers. Land, entertainment and transportation is freely offered, and the minimum and maximum wages, common to forty-nine different employments, are given.

Farmers and laborers are informed they can secure as wages 2½ to 4 pesos per day, or the equivalent of $1.12½ to $1.80 gold per day.

Before long, we shall know whether the offers of the Territory of Hawaii are more acceptable than those indicated.

As reported to me and compiled January 1st, 1905, there were employed to secure the sugar crop of 1905, 35,848 field laborers, who produced from 95,443 and 51-100 acres 427,365 and 68-100

tons of sugar, equalling 11 and 91-100 tons of sugar from 2 and 693-1000 acres to each field hand employed.

There were also employed, and their wages came from the above product, 4,338 common laborers, 1,522 semi-skilled laborers, 1,200 skilled laborers, or a total of 7,060 persons, not including management.

SUB-DIVISION OF TERRITORIAL CANE LANDS.

Among whom shall the Government divide the cane lands reverting to it? With those who cultivate the lands and can crop only 2 and 693-1000 acres each per year? Or shall it be with those who desire to get individual possession and become independent planters? Will the latter work in the fields themselves, or do they expect to employ the classes of labor now working the fields? If the latter is the intent, how is the Territory to be benefited financially, socially or politically?

The owners of plantations have no individual ownership now; they have certificates of stock, which exactly indicate their ownership in the property as a whole. The same ownership is open to the humblest employe where the securities are offered at public sale. The same privilege is open to those who now desire to intervene.

Under the well-meant, but not thoroughly digested edict, that "Hawaii must be developed on American Lines," this Territory of Hawaii is forced against problems that are the most momentous in the world, and that are occupying the best minds, from the earnest President of the United States, statesmen and students down.

Civilization demanded facilities that could only be secured by joining together in a treasury the savings of the many, hence, the forming of corporations.

Corporations have developed into powers that almost exceed the powers of Government.

Agriculture in Hawaii required similar combinations of savings to make possible the utilization of her naturally unproductive, waterless soil, hence, the great agricultural corporations of Hawaii.

Modern business and utility organizations cannot be resolved into the elements of individuality from which they sprung.

The shoemaker cannot go back to his lone last and bench, nor the spinner to the spinning-wheel, nor the carpenter to hewing logs.

The United States Steel Corporation cannot be resolved into its original component parts.

No more can the equally highly organized Hawaiian sugar plantations.

The Territorial Government, in its anxiety to square itself with the edict, is making certain efforts, wisely or unwisely.

First. It tried to individualize a part of one plantation by

urging it to share with immigrants, ignorant, more or less fanatical, disinclined to work and afflicted with wholesale bickering. It takes imagination not to call the experiment a lamentable failure.

Second. It found associations, endeavoring to profit by the sub-division land policy of the Territory and make the Government a partner in hold-up schemes on the plantations.

Third. The Government is now contending with local schemes that seem to have a similar purpose.

Fourth. If simply domiciling European peasantry on an acre or two of land of questionable quality is "Development on American Lines," the term has a new meaning. Try to figure out land proprietorship and adjustment for 43,158 people in their relation to the 95,443 and 51-100 acres cropped by them annually. If ownership is provided for a thousand, it must be provided for all. Adjacent arable land, sufficient for the purpose, does not exist. Except in rainfall districts, there is no naturally watered land. Irrigation districts require all available water (and more too) for cane. Cane is the only vegetation that can stand the expense of providing irrigation, and has practically appropriated every source of water supply.

What is to be done?

Those who are trying to force unduly this Territory, should thoroughly inform themselves and present a practical solution of the problems they force.

Over a year ago, the only rational, practicable answer was given in a request for a certain class of labor to tide over for a period of ten years while we sought relief.

Since that request has received no attention and the pressure is stronger than ever, this paper suggests an effort in another direction, but with no prediction as to its success.

WHAT IS TO BE SUBSTITUTED FOR INDIVIDUAL OWNERSHIP?

Judge Grosscup, of Chicago, thinks the employee must come in on the same basis as those who put their savings into an enterprise and become an owner of its securities himself and thus put himself on a level with the owners.

It is within the power of legislation to provide a means and to re-adjust the equities of the unearned increment and special privilege. Any entity legislation has created, legislation can control.

Fortunately for this Territory, the unearned increment is not as great as popular imagination believes it to be, in fact the figures show there is none.

The profits that have built up large fortunes here have been built on the world's free market and the reciprocity favors of the United States.

Possibly our cane land question can be adapted and settled on these lines of acquirement of a share in the general interest, in-

stead of half wrecking the industry by the idiosyncracies of numerous individual owners of land, who cannot be made to agree if indisposed, and human nature is generally indisposed.

CAN HAWAII AMERICANIZE AND DIGNIFY LABOR?

It can only be done by substituting "The Man with Machinery" for "The Man with the Hoe," as has been done in the United States.

This means the possibility of citizenship labor in place of alien.

The "Man with Machinery," making himself many times as effective as "The Man with the Hoe," cheapens the cost of production, and raises himself financially, intellectually and socially.

Whether the effort is worth making in this Territory lies entirely within the judgment of the plantations and the Government.

It might be wise for the Government to consider retaining for the present its ownership of cane lands and use them as a lever to force the issue above indicated.

Our only alternative is to make an effort on these lines or to seek the world over for peasants with peasants' minds and contentment.

As soon as the peasant has arrived, our Territorial educational system, very properly under the mandates of civilization, tries to overcome the peasant mind and contentment with humble conditions, and generally succeeds and also deprives Hawaii of his services. Then the old search is renewed.

THE PUBLIC SCHOOLS OF HAWAII—THEIR RELATION TO LABOR.

Education often has a negative value if pupils are run out into the world, filled with lofty ideals, but not knowing where or how to make a decent living.

Our youth, in a general sense, should be educated to fill such opportunities as the Territory can offer. If they cannot find refuge in the industry that yields ninety-eight per cent. of our produce, what place can we find for them?

I have examined the "Course of Study" from the First to the Eighth grade and I find patriotism taught and a wide range of studies, many of which gratify the pedagogic spirit rather than equips the pupil for his struggle in life.

I have failed to find a word as to what Hawaii needs in the daily occupations from a pupil when he is ready to assert his manhood.

I have failed to find a suggestion as to what occupations Hawaii can furnish her boys and girls. The opportunity for a variety of employments in Hawaii is so limited, practical suggestions would be of great value to those who must seek a livelihood.

The authorities have a great responsibility resting on them which should be recognized, practically, not theoretically.

CONCLUSIONS.

Justice is due the sugar planters of Hawaii.

They are not land monopolists; they are the most daring land reclaimers the world has ever known.

They have made the desert support a commonwealth.

They have made agriculture a business of the highest organization.

They have wrung nearly every possible drop of water from the caverns of the earth.

They have caught nearly every drop of water that flows within the reach of man on these Islands.

Still the demand is for more water.

The investment per acre cropped is unparalleled by any other agriculture in the world.

They have absolutely created ninety-eight per cent. in value of all the products of the Territory.

Their lands can grow no other crops commercially.

Ruin them and you ruin Hawaii, so far as human foresight can predict.

He who claims otherwise is an astrologer and sees stars.

They based their agriculture on contract labor, which, whatever its faults, bettered the condition of the laborer.

Labor possibly did not always receive its just dues. Evidently labor intends to settle that point in the future.

The labor situation might have been bettered in Hawaii, but hindsight has excelled foresight for a decade and a half at least.

They have supported an educational system that has deprived them of needed labor.

They have been between the devil and deep sea of their pocket books and their missionary consciences.

The latter have won often enough to give them great credit.

Ownership in plantations is not so exclusive all stockholders may be termed sugar barons.

What ails the dear general public, and its wide-spread distress in Hawaii, is what ails it the world over, it buys high and is sold out low.

It gets into a game where the cards are stacked and the pot already spoken for.

The plantations are distressed for labor and are forced to two choices.

First. To seek peasant labor, Occidental or Oriental, the world over at enormous expense.

Second. To endeavor to make a place for more effective, intelligent, adequately paid and domiciled self-respecting labor by

trying to substitute "The Man with Machinery" for "The Man with the Hoe."

Far from this paper to assert the machinery can be devised, but to urge the attempt. Many more difficult mechanical problems have been solved.

If the plantations should conclude to make the effort, it is to be hoped "The Hawaiian Engineering Association" may be a chief factor in creating the various machinery needed and that the educated young men of Hawaii may operate it.

May we hope invention, fostered by the Hawaiian plantations, may yet dignify labor, and the educators of Hawaii may teach the dignity and worth of physical labor.

TABLE NO. 1. PHYSICAL—SUGAR LANDS.

Lands Utilized For Cane Including All Other Lands Occupied By Hawaiian Sugar Plantations.

Character of Plantations	Acres Owned	Acres Leased	Information Reiused	Total Acres	Income acres in cane	Possible for Cane	Otherwise Cultivated	Pasture	Forest	Worthless and Gulch
Irrigation exclusively ...	149,647½	133,538½	28,004	311,190	104,726	18,013	2,290	53,956	107,066	25,136
Irrigation partly	23,329½	12,768	4,750	40,847½	24,640	2,497	16	2,778	8,958½	1,957½
Total Irrigation.....	172,977	146,306½	32,754	352,037½	129,366	20,510	2,306	56,734	116,024½	27,093½
Rainfall Exclusively.....	82,147	332,897½	109,098	524,142½	68,166	4,875		112,129	230,915	108,794
Grand Totals	255,124	479,204	141,852		197,532	25,385	2,306	168,863	346,203½	135,887½
Recent ditch installations add.....						15,000	deduct	15,000		
						40,385		153,863		
Total Acres occupied by Sugar Plantations ..				876,180						

TABLE NO. 2. PHYSICAL DATA.

Equipment of Hawaiian Sugar Plantations.

CLASSIFICATION.	PLANTATIONS						TOTALS.	
	Irrigated.		Partly Irrigated.		Rainfall.			
TRANSPORTATION--								
Steam Railway	446 5/8	miles	19	miles	69	miles	534 5/8	miles
Steam Railway, Independent Organizations	110	miles	20	miles	52	miles	182	miles
Movable Track	115 1/2	miles			6 3/4	miles	122 1/4	miles
Cars, cane, number.....	6,698		322		776		7,796	cars
Locomotives, plantation, number	66		5		17		88	
Cane Flumes	29 3/4	miles	24	miles	324 3/4	miles	379 1/2	miles
Cane Cableways.....	4/5	miles	5 1/4	miles	33 1/2	miles	39 1/2	miles
IRRIGATION BY GRAVITY—								
Reservoirs, number.....	216		22		12		250	
Storage Capacity 8,101,000,000		gals.	72,750,000	gals	8,000,000	gals.	8,181,750,000	gals
Water Supply Ditches.....	435	miles	68	miles			503	miles
Maximum Ditch Supply per 24 hours	923,300,000	gals.	170,000,000	gals.			1,093,300,000	gals
*Distribution Ditches	713	miles	*4	miles			717	miles
Ditch Tunnels	37 1/4	miles	32	miles	2	miles	71 1/4	miles

* The irrigation supply on Partly Irrigated Plantations has just become available, so the distribution ditches are incomplete.

TABLE NO. 2. PHYSICAL DATA.—Continued.

IRRIGATION BY PUMPING—									
Artesian Wells, number.....	425		1		2		428	wells
Artesian Wells, greatest depth.	1,125	feet	100	feet	275	feet		
Capacity of Wells per 24 hours.	486,750,000	gals.	8,000,000	gals.			494,750,000	gals
Pumps, number	92		4		6		102	
Pumps, horse power.....	26,139	H. P.	475	H. P.	240	H. P.	26,854	H. P.
Pumps, capacity per 24 hours..	591,200,000	gals.	9,000,000	gals.	7,072,000	gals.	607,272,000	gals.
Highest lift of water.....	560	feet	450	feet	600	feet		
Pipe line mains.....	55 1/2 miles		7 1/2 miles		9 2/3 miles		72	miles
Size of pipe lines.....	16" to 48"		3" to 24"		3" to 9"			
Cost of pumping per 24 hours, exclusive of repairs and varying	$4,431.38		$ 125.00				$4,556.38	
CROSSING GULCHES BY PIPE LINES—								
Pipe line syphons	62,950	feet						
Greatest depth of carry.....	700	feet						

IRRIGATION SUMMARY FOR 24 HOURS—

Maximum Capacity of all sources of irrigating water supply, ditches and wells ..... 1,684,500,000 gals.
Average Irrigating Capacity per 24 hours from all sources..... 1,186,700,000 gals.

TABLE NO. 2. PHYSICAL DATA.—Continued.

Equipment of Hawaiian Sugar Plantations.

CLASSIFICATION.	PLANTATIONS						TOTALS.	
	Irrigated.		Partly Irrigated.		Rainfall.			
STEAM BOILERS AND MILL ENGINES—								
Boilers, number	309		28		93		430	
Boilers, horse power.....	60,529	H. P.	3,675	H. P.	14,694	H. P.	78,898	H. P.
Sationary engines, number....	116		24		89		279	
Stationary engines, horse power.	15,810	H. P.	1,222	H. P.	6,063	H. P.	23,095	H. P.
BUILDINGS AND HORSES AND MULES—								
Buildings, number	4,976		754		1,813		7,543	
Horses and mules, number....	3,964		1,207		2,477		7,648	
MANUFACTURE OF SUGAR—								
Maximum capacity per 24 hours	2,189	tons	309	tons	1,013	tons	3,511	tons
Fertilizers used annually.....	43,431	tons valued at approximately					$2,213,289.03	

SUGAR IN JAVA.

The *Journal des Fabricants de Sucre* has an interesting article on the sugar industry in Java, which, as will be seen from the following table, has made progress during the past ten years:

SUGAR PRODUCTION OF JAVA.

Year.	Production—Tons.
1896	534,390
1897	586,299
1898	725,030
1899	762,447
1900	744,257
1901	803,735
1902	897,130
1903	931,286
1904	1,055,043
1905	1,039,188

In addition to the practical doubling of the crop, it has to be noted that the proportion of fine sugar of first runnings has also increased in a very marked manner, while the production of the second runnings has hardly varied. In 1896, on a total extract of 8,652,532 piculs (133 1-3 lbs.), there were 8,282,351 piculs of first runnings and 740,363 piculs of low sugar. In 1905, on a total crop of 17,082,624 piculs, 16,718,332 piculs of sugar were first runnings, and 728,584 piculs of commoner sorts. In the meantime, it will be noticed with regret that our own West Indian colonies are only just commencing to improve their production of sugar, three-fourths of their crop consisting still of products made on antiquated and wasteful processes 350 years old.

It will be noted that the Java sugar factories work on a large scale, the average production being 60,068 bags in 1905, whereas in France the average produced by each factory is 36,000 bags in the year; in Germany, 63,000 bags per factory, and in Austria 72,000 bags per factory. Java thus works under excellent conditions for economy, and it would be very interesting to compare, if the figures were available, the average yield in the many tiny plantations in our own West Indies, which cannot compete until they work on a proper scale, in the open markets of the world. In 1905 the average yield in merchantable sugar in Java was 9,900 kilos per hectare, against 10,200 kilos in 1904. The net production in Java is thus a little under two

tons per acre. The average yield in canes per hectare (2½ acres) was 95 tons per hectare, in 1905 against 94.8 in 1904. The sugar yielded per hectare was in 1905 9.9 tons per hectare, and in 1902, 10.2. The yield from the cane in sugar was 10.37 per cent. in 1905, and 10.74 in 1904. According to these figures Java is less favored than Germany, Austria, Russia, France, and most of the European beet countries. As regards the yield for the industrial yield in raw sûgar in 1905-6, in Germany, it was 15.21 per cent., in Austria-Hungary 15.02 per cent., in France 12.49 per cent., in Russia 15.61 per cent. It is possible, however, that a portion of these differences may be accounted for if molasses are made to any extent in Java, or if any portion of the by-products are distilled into rum. In consequence of the low wages and of extremely scientific production, Java sugar is produced at a very low price. Dividends of 10, 15, and even 20 per cent. are not rare among factories. The cost of production in 1904 varied between 4.29 and 5.92 florins per picul, including expenses for new buildings, the purchase of machinery, and transport of material. These costs are equivalent to 14 fr. 586 and 20 fr. 128 per 100 kilos, or in English currency, to from 6s. 6d. to 8s. 6d. per cwt. In some of the factories the cost of production is very much less than these figures. In consequence of the very high prices of 1904-5 a considerable number of the Java sugar planters desired to extend their plantations, and to increase the power of their machinery, but the government rejected the greater part of the requests for the increase in the cane plantations. This refusal was caused by the fear that, by the creation of new plantations, any drought would expose the native population to the risk of a dearth of water for the cultivation of rice, which is necessary for its sustenance. In other parts in the east of Java, these difficulties did not exist, and a number of new factories were put up. In consequence of the recent prosperity of the factories, the government tax upon them has been raised against the produce of the planters. Countries desirous of extending and improving the production of manufacture of sugar, and particularly our own West Indian colonies (which are so much behind the rest of the world), would do well to study what has been done in Java, with the remarkable result of the doubling of the production within ten years, at a time when our own colonies were complaining of being ruined.

DENATURED ALCOHOL IN CUBA.

PRODUCTION, USE, AND CONSUMPTION.

Consul General F. Steinhart, of Habana, in response to inquiries, furnishes the following report on the production of denatured alcohol, the uses to which put, and the approximate consumption in the island:

The principal consumption of denatured alcohol up to the present time in Cuba is in the domestic household. Consumption in motive power is as yet insignificant, as there are but few motors operated by combustion of alcohol. There are no chemical industries, properly so called, in Cuba, and the pure alcohol is used in mixture with drugs. For illuminating purposes, denatured alcohol is beginning to be used by students and professional persons who reside in the country.

The increase in consumption of denatured alcohol is incalculable from the day that the Cuban planter is convinced that he is, so to speak, throwing away or making a gift to the export commerce of thousands of tons of saccherose in the form of molasses. It may be asserted that the medium of the molasses sold as exhausted contains more than 50° polarization. Consequently, if this molasses is converted into alcohol, setting up distilleries in connection with sugar factories, it would solve the problem of fuel, the most important in the sugar industry, either by the use of motors with an alcohol basis, or by burning it as a spray over the bagasse, as is done by the planters of Louisiana with petroleum.

QUALITY OF THE NATIVE PRODUCT.

For domestic as well as for industrial purposes, two kinds of alcohol of different density are employed, viz., that called aguardiente, generally 20° to 22° proof Cartier, or 60 centesimal, and rectified olcohol 42° Cartier proof or 90 to 92 centesimal, and as both kinds have the same origin, the difference consists only that the former contains more water and has in solution slight quantities of oily acids, characteristic of the main liquid, while that of 90° proof may be considered practically pure. For denaturalization, alcohol of 90° to 92° proof is generally used.

As the alcohol produced and used in Cuba proceeds from the fermentation of molasses or of the juices of the sugar cane, it does not contain any fusel oil. This substance has never been considered as a problem in hygiene, nor are there any special regulations in regard to it. Spirits, however, accompanied by the products when first distilled (mauvais gouts de tete, as the

French say), contain methylic alcohol, and if accompanied by the products of secondary distillation they contain something of fusel oil. As these products are, however, easily separated by rectification, alcohol in use in Cuba, such as leaves the distilleries, is practically pure.

PRODUCTS OF SUGAR CANE ALONE USED.

No other prime material is used in the manufacture of alcohol than the products of the sugar cane. Up to the present time the substance employed to denaturalize alcohol is camphor at the rate of a gram per liter of alcohol, but the treasury department of Cuba has requested the Academy of Science to designate some agent for denaturalization more convenient and the academy has suggested that a mixture composed of napthaline and (formical) aldehydro be used at the rate of 50 centigrams of each per liter. If the secretary of the treasury accepts the proposal of the Academy of Science, the cost of denaturalization of alcohol will be $0.0047 per American gallon.

The camphor now employed costs about $0.0135 per American gallon, but as there does not exist any practical means to determine quantitatively the amount of camphor dissolved, and as, moreover, the employees of the department do not witness the denaturalization, some suppose that the manufacturers put into the alcohol they make for sale a much less quantity of camphor than is ordered by the authorities. The present cost of camphor is $1.65 per pound; of formel, $0.25, and of naphthaline, $0.90.

Denaturalization is tested by the organileptic characteristics such as smell, taste, etc., but in case of litigation or disagreement between parties a sample is sent to the national laboratory, where the alcohol is examined and analyzed according to the usual chemical process.

The cost of the denaturalized alcohol which is generally sold for public use is from $48 to $50 Spanish gold per large pipe, which contains 173 American gallons. The difference depends upon the graduation, generally 40° to 42° Cartier (90 to 92 centesimal).

It must be taken into consideration that the graduation or proof is taken in commerce as the temperature of the air (atmosphere), and as the apparatus is graduated at from 15° to 17.5° Centigrade, the real strength of the alcohol is about 36° to 40° Cartier.

Retailers sell the "garafon" (demijohn), about 4.55 gallons, at $1.60 to $1.70 Spanish silver, while in bottles of about the fifth of a gallon in capacity at $0.08 Spanish silver.